SAFETY IN NUMBERS: OVERCOMING STATISTICS ANXIETY IN UNDERGRADUATE NURSING STUDENTS THROUGH TEAM-BASED LEARNING

by
Marissa Brash

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Abstract

Many undergraduate students experience mathematics anxiety in nursing school. This study explored how changing from a curriculum using traditional lecture and test-based pedagogy to a team-based learning approach would affect the relationship between statistics anxiety and statistics self-efficacy in traditional and nontraditional undergraduate nursing students. The student investigator conducted a quasi-experimental mixed-methods study using a control group with a standard statistics curriculum and an intervention group who had a team-based learning statistics curriculum. Students in both groups completed a pre-test/post-test electronic survey on statistics anxiety and statistics self-efficacy. Using a difference-in-difference regression analysis, the student investigator analyzed the quantitative data. The student investigator interviewed the students after the course concluded, providing further qualitative data that the student investigator analyzed using thematic analysis. Ninety-six students completed the Statistics Students Survey, 68 (70.8%) of whom received the intervention curriculum. The student investigator observed a moderate correlation between anxiety and self-efficacy among the students ($r = -0.53$). The intervention group reported a statistically significant decrease in anxiety compared to students receiving the standard curriculum. However, there was an absence of statistical difference in self-efficacy between the two groups. Fifteen students completed one-on-one interviews, providing evidence that statistics anxiety inversely relate to statistics self-efficacy. Overall, the team-based learning intervention increased self-efficacy and decreased the anxiety of the participants. The results illustrated that team-based learning decreases statistics anxiety in traditional and nontraditional undergraduate nursing students, which provides crucial implications for teaching, attrition levels, and nursing shortages.

Keywords: statistics anxiety, statistics self-efficacy, team-based learning

Dissertation Advisor: Dr. Elizabeth Todd Brown

Dissertation Approval Form

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E. Todd Brown 03/17/2020

Ranjini JohnBull 03/17/2020

Dedication

This dissertation is dedicated to my family. To my husband, Joe, who has always encouraged me to follow my dreams and provided me with the time, space, and resources needed to complete this degree. Thank you for challenging me, inspiring me, and supporting me unwaveringly. To my daughter, Kennedy, who has always been my biggest cheerleader, and gleefully "attended" classes with me in the early mornings of the weekends. To my father, Stewart, who has paved the way for me in medical education. Finally, to my mother, Sherri, a hardworking nurse who always wanted her daughter to have a college education. Your love and support have made this possible.

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Acronyms

Acronym	Explanation
ANOVA	Analysis of Variance
BSN	Bachelor of Nursing
CBL	context-based learning
COSSAA	Composite Study of Statistics Anxiety and Attitudes
CSSE	Current Statistics Self-Efficacy
DID	Difference-in-Difference
GPA	Grade Point Average
IRB	Institutional Review Board
LM	Logic Model
MAS	Mental Agility Series
MSES	Mathematics Self-Efficacy Scale
MSW	Masters of Social Work
PBL	Problem-Based Learning
PoP	Problem of Practice
RN	Registered Nurse
SA	Statistics Anxiety
SAM	Statistics Anxiety Measure
SAS	Statistical Anxiety Scale
SAT	Scholastic Assessment Test
SATS	Survey of Attitudes Toward Statistics
SELS	Self-Efficacy to Learn Statistics
SSE	Statistics Self-Efficacy
SSS	Statistics Student Survey
STARS	Statistics Anxiety Rating Scale
SMAS	Students' Mathematics Anxiety Scale
STEM	Science, Technology, Engineering, and Mathematics
TBL	Team-Based Learning
TOSRA	Test of Science Related Attitudes
ToT	Theory of Treatment
ZPD	Zone of Proximal Development

Executive Summary

Legislation requiring nurses to attain a bachelor's degree to maintain employment in the hospital setting has exacerbated the preexisting shortage of nurses (Osterman et al., 2009). On its surface, the need for higher education is not a significant deterrent for those desiring to enter the nursing field; however, the presence of required mathematics-related courses in what may otherwise appear a non-mathematics-related profession could become an obstacle for students to overcome (Zeidner, 1991). Further compounding the shortage, the majority of students seeking a nursing degree are nontraditional, adult learners who bring with them preconceived notions of mathematics-related subject difficulty and their often negative past experiences with the subject matter (McMullan et al., 2012).

Intervening on Anxiety

Therefore, the student investigator conducted a needs assessment to establish the efficacy of the intervention instrument included data from 18 participants in an educational doctoral program at the Johns Hopkins University. Accordingly, the results of the assessment revealed evidence of significant statistics anxiety for students enrolled in a non-mathematics major.

Assessing Anxiety

This research proposes a change in undergraduate nursing statistics curriculum, which would shift the focus from traditional lecture-based teaching and test-based assessment to Team-Based Learning (TBL) and collaborative assessments. This change would address the statistics anxiety of individuals in nursing education programs. Therefore, the proposed curriculum change aims to modify students' experiences with statistics by leveraging social strategies, such as collaboration and communication, as methods by which to combat attrition rates.

The student investigator conducted a quasi-experimental mixed-methods study in a school of nursing at a large Southern California university to understand better the relationship between Statistics Anxiety (SA), Statistics Self-Efficacy (SSE), and attrition of traditional and nontraditional students. The control group received the standard curriculum consisting of traditional lectures, five-module exams, 14 individual quizzes, and a cumulative final exam. The intervention group received the new TBL curriculum. Moreover, this curriculum altered the pedagogy from lectures to group work and retained the module exams, while augmenting the other assessments from 14 quizzes to five group projects, and from a final exam to a group presentation.

Furthermore, students in the control and intervention groups completed an electronic survey on SE and SSE at the beginning and the end of the semester. Additionally, the student investigator conducted one-on-one interviews with students who had completed the class and those who had dropped out before the semester's end.

A Social and Collaborative Framework for Nontraditional Students

The theoretical framework addressed SA, SSE, the type of learner, and the attrition rate as they collectively relate to current, and perhaps continued, nursing shortages. The constructs of the theoretical framework included the social cognitive theory (Bandura, 1986) and andragogy (Knowles, 1980).

The Results

A combination of quantitative and qualitative data provided an opportunity for the student investigator to conduct an in-depth analysis of the intervention outcomes. The results of the difference-in-difference (DID) analysis indicated a statistically significant change in anxiety among students who received the intervention curriculum compared to students who had received the control curriculum ($p = 0.041$). Further, the TBL intervention had a significant effect on the students' SA levels change, but only in cases when the DID analysis was unadjusted to the confounders, including gender, age, self-efficacy, or the anxiety score at the time of survey completion. Finally, the student investigator analyzed the qualitative data from the one-on-one interviews conducted with students from the intervention group using thematic analysis and triangulating the results.

In this case, the DID regression analysis did not identify a statistically significant change in self-efficacy among students who received the intervention curriculum compared to the students who received the control curriculum (p-value = 0.215). Similarly, a thematic analysis of qualitative data further confirmed that students' SSE did not significantly relate to TBL.

Intervention Impact

The goal of this study was to determine whether substituting quizzes and a final exam with TBL projects improved SSE and decreased statistics anxiety in traditional and nontraditional students. As a result of participating in the study, the statistics course instructor recognized how diversifying pedagogies and assessment methods impact student anxiety levels in undergraduate nursing statistics courses.

CHAPTER 1

Statistics Anxiety in Undergraduate Nursing Students

Over the past decade, there has been an enrollment surge, especially in re Registered Nurse to Bachelor of Science in Nursing (RN to BSN) programs, in which students who are already registered nurses seek to earn a bachelor's degree (Romp et al., 2014). This enrollment surge is due in part to a policy based on a federal survey published in 2008 stating that only 3% of new nurses had graduated from a non-degree program. Moreover, the survey established that 58% had graduated from a community college, and 39% had graduated from a 4-year college (Glazer & Alexandre, 2008) . At the time of this survey, only 50% of the 3 million registered nurses working in the United States had received a bachelor's or master's degree in nursing (American Nurse's Credentialing Center, 2013). In 2010, the Institute of Medicine (2011) released a report advocating for an increase in the percentage of nurses with bachelor's degrees to 80% by 2020. Since then, hospitals across the country require nurses to have at least a bachelor's degree to qualify for employment.

Because hospitals with more nurses who hold bachelor's degrees have better patient outcomes, many hospitals prefer to hire nurses with bachelor's degrees (Estabrooks et al., 2005). However, there was a shortage of nurses with those qualifications (Osterman et al., 2009). Lawmakers in California, to further complicate matters, introduced a bill in 2009 that required nurses employed in the state to have bachelor's degrees by 2019. Therefore, nurses returned to school to meet this standard.

As could be expected, these regulatory changes have caused a significant shift in the population of students within nursing programs, as more adult students began to enroll in these programs following their aperture from academia (Altmann, 2011). Of these non-bachelor degree nurses returning to school, the average age of those enrolling in BSN programs is 30 years old; many have had families and successful careers for more than a decade (Romp et al., 2014). Although accrediting bodies often require practicing nurses to complete continuing education units, these units frequently fail to mirror the rigid structure expected of courses for those pursuing an academic degree (Levett-Jones, 2005). A trend has developed with this subset of adult learners who already hold nursing degrees entering into baccalaureate nursing programs: anxiety manifests in many as they attempt to navigate required statistics courses (Onwuegbuzie & Wilson, 2003).

The principles of *quantitative literacy* are essential to consider to understand better the impact of Statistics Anxiety (SA) on nursing students. Quantitative literacy comprises three components: foundational and mathematical skills, quantitative reasoning abilities, and positive attitudes and beliefs about mathematics and quantitative reasoning (Madison, 2003). The third component is a result of the first two. It suggests that students who lack a strong foundation in mathematics and quantitative reasoning may develop negative attitudes and beliefs toward the mathematics and quantitative reasoning skills required in the statistics curriculum (Jordan & Haines, 2006).

Furthermore, *statistical literacy* is a concept that relates to quantitative literacy, goes beyond the related foundation ofr mathematics, and focuses on the student's ability to read, interpret, and communicate data and analytics (Schield, 2004). Both quantitative literacy and statistical literacy are not only necessary, but are crucial for a student to succeed in college statistics courses. Researchers have demonstrated that when a student suffers from statistics-related anxiety, it could contribute to statistics illiteracy and hinder the student's ability to effectively comprehend the program's required course (Earp, 2007).

Further complicating the problem of SA is the reality that students who struggled with mathematics classes during childhood may expect to fail at mathematics and statistics courses later in life (Bandalos et al., 1995). These real or perceived past failures contribute to growing anxiety, affecting success in mathematics-based subjects of adult learners (Baloğlu, 2003). As such, adult students may conclude that childhood failures indicate a deficiency in their capability with subjects involving numbers (Pajares & Miller, 1994). Therefore, feelings of failure and earlier experiences in mathematics courses may relate to SA.

Overall, SA is a subsection of the broader category of mathematics anxiety. *Mathematics anxiety* is negative cognitions, avoidance behaviors, and the feeling of being pressured and inadequate in the performance that interferes with solving mathematics-related problems in general life and academic situations (Andrews & Brown, 2015). Students with high levels of mathematics anxiety may additionally have low levels of mathematics self-efficacy: the belief that they can be successful in mathematics-based subjects, impacting how these students will approach specific tasks (Bandura, 1986; Lee, 2009). Consequently, research shows that perceived levels of low self-efficacy impact anxiety, attitude, and achievement in college statistics students, including those nurses who aspire to enhance their academic achievements (Finney & Schraw, 2003; Perepiczka et al., 2011).

Upon returning to higher education, these nurses who have been practicing with a credential, license, or associate's degree, sometimes discover that statistics is a mandatory course, part of the degree requirement for a bachelor's degree in nursing. Because of their negative experiences with the previous mathematics-related subject matter, statistics could exacerbate feelings of anxiety, discouraging individuals from fulfilling their degree requirements. This anxiety results in an increased attrition rate, as students enroll in the nursing program and then withdraw before completing the program (MacKusick & Minick, 2010). Accordingly, the student investigator examined the Problem of Practice (POP) of how SA and Statistics Self-Efficacy (SSE) affect traditional (ages 18–24) and nontraditional (ages 24 and over) students enrolled in statistics courses as part of an undergraduate nursing program at a large Southern California university.

Traditional Nursing Education

The present-day nursing education system in the U.S. offers many modalities for earning a baccalaureate degree in nursing. Most commonly, students enroll in a traditional, 4-year baccalaureate pathway, registered nurse to bachelor of science completion program (RN-BSN), or accelerated programs (Brown et al., 2001). Schools design each of these models to meet the needs of different students with program curriculum formats that meet the requirements of the medical practice. Additionally, schools design accelerated programs for individuals with previous college degrees who seek to change their career paths and earn a baccalaureate degree in nursing at a faster pace—under 22 months (Pepa et al., 1991). Accelerated programs are an effective way to educate nurses properly in less time and, thus, respond to a nursing shortage. In a study by Aktan et al. (2009), accelerated nursing students showed an even higher grade point average (GPA) compared to traditional nursing students. However, there were no differences between the two groups in the National Council Licensure Examination passing rates, transitioning to the professional role, employment, professional development, certifications, and reasons for choosing the nursing profession.

Traditional pedagogies have led to many accomplishments in nursing education, bringing it from hospital-based programs to doctoral education (Diekelmann, 1995). Throughout the years, many authors have described traditional nursing education as something that should enhance quality and harmonize with the requirements for evidence-based practice. The traditional nursing curriculum is focused primarily on behavioral outcomes, following the ideas of a teacher-centered approach and its benefits (Stanley & Doughery, 2010). Moreover, the medical model in nursing education centers around the illness etiology, and treatment remains the dominant approach (Grendell, 2011). Nevertheless, the aim of this model is that nurses include the content necessary for earning a degree, focusing on specific skills, processes, and outcomes needed for learning (Ironside, 2015; Stanley & Doughery, 2007).

Furthermore, traditional pedagogies use lecturing as a teaching strategy, which is useful to transmit the information necessary for students to attain these skills and competencies (Hasanpour-Dehkordi & Solati, 2016). Additionally, these traditional methods include reading in textbooks, using didactic lectures with or without slides, incorporating objective testing, and students critiquing papers of published research (McCurry & Martins, 2010). Although this lecture-based format is usually non-interactive and occurs primarily in the classroom, it is a helpful way to cover a large body of knowledge (Ozturk et al., 2008). Students also have an opportunity to gain practical clinical experiences in a long-term care setting where their preceptors assign them to individual patients for the provision of nursing care, which is an experience linked to a significant knowledge gain in students (Schlairet & Pollock, 2010).

Traditional lecture formats in nursing education are usually situations where educators teach, while students receive the information passively and ask questions. Ward et al. (2018) criticized this approach as being insufficient to meet the needs of today's learners and advocates for using alternative approaches. In Pugsley and Clayton's study (1996) that compared the role of traditional and experiential learning in changing student's attitudes toward research, they noted that the traditional model educators used was the lecture format, article critiques, and comprehensive examinations throughout the semester. Moreover, students in their study using the experiential model worked on hands-on problem-solving activities, mini-research projects, critiques, and eventually, demonstrated more positive attitudes toward research.

Furthermore, according to several authors, the appropriateness of traditional pedagogies for facing modern challenges and changes in patient care is questionable (Brown et al., 2001; Gholami et al., 2016; Stanley & Doughery, 2007; Tanner, 2010; Ward et al., 2018; B. Williams et al., 2007). For a considerable amount of time, nurse educators have identified significant gaps and advocating for a practice shift in traditional nursing education. Some of the critical challenges for contemporary medical systems concerning these issues include nurse shortages, more complex needs of patients due to an aging population, increased incidence of chronic illness, lack of critical thinking and competence in nursing graduates as well as their lack of readiness for practice, increased globalization of health care, and incorporation of informational technologies in education.

Almost 30 years ago, Diekelmann (1995) questioned the achievement of traditional pedagogies in teaching students how to learn and called for the inclusion of interpretive pedagogies, which she described as "phenomenological, critical, feminist, and postmodern" curriculum (p. 195). Correspondingly, additional research highlighted the importance of using narrative, interpretative pedagogies in nursing education, and moving away from focus content coverage toward student learning (Forbes et al., 2009). According to Ironside (2015), in narrative pedagogies, the context in which educators teach nurses is significant. She suggested that students and teachers co-create learning experiences in collaboration with one another, using a new language and basis for teachers and shifting it away from the content and skills needed. Instead, students would learn through the understanding of mutual experience.

Additionally, researchers identified multiple techniques useful in nursing education that embrace the principles of narrative pedagogy. Nurse educators use strategies grounded in these tenets, such as storytelling, case studies, simulations, and digital reflective journals. These are useful ways to stimulate self-directed learning in students by mutual collaboration between them and a holistic approach to patient-centered care (Grendell, 2011). According to McCurry and Martins (2010), millennial nursing students prefer innovative teaching approaches, including active learning assignments, reading quizzes, clinical nurse researcher presentations, and collaboration with clinical course assignments. The combining of these methods with traditional assignments could serve as a useful tactic.

The innovative approaches to nursing education include *problem-based learning* (PBL) and its form, *context-based learning* CBL). Many authors have examined the success of these strategies in nursing education compared to traditional methods. They have shown that they could facilitate positive traits, communication skills, responsibility, motivation, and learning scores (Hasanpour-Dehkordi & Solati, 2016) as well as positive attitudes to personal aging (B. Williams et al., 2007). In a quasi-experimental study conducted by Gholami et al. (2016) that sampled 40 nursing students, the researchers taught the students using PBL, which showed a significant increase in critical thinking and metacognitive awareness.

Another common alternative approach to traditional nursing education that facilitates self-directed learning and critical thinking abilities is the *flipped classroom*. "Students prepare assignments independently outside of the classroom and master the materials inside the classroom via activities such as role-play, case scenarios, simulation, and group discussions (Ward et al., 2018). The studies that have applied quasi-experimental design and sampled nursing students showed that using a flipped classroom is linked to better performance in some parts of exams (Geist et al., 2015; Harrington et al., 2015) as well as short-term knowledge on evidence-based nursing and self-efficacy in practice (Chu et al., 2019).

In clinical practice, nurses must collaborate and be part of a team alongside other medical professionals and staff members. This practice is why TBL and its forms have become a prominent method that educators use to prepare nurses. According to Grendell (2011), in client-centered-based care, nurses know how to collaborate because teamwork is a crucial part of interdisciplinary education programs. In an Iranian study that sampled senior nursing students, the learners who completed a given task trough TBL demonstrated an increase in respect, self-awareness, self-evaluation, communication skills, and responsibility, as well as increased motivation and learning scores compared to the traditional method (Hasanpour-Dehkordi & Solati, 2016). Furthermore, Stanley and Doughery (2007) argued that the role of professors is to create a context in which they have shifted from the content-laden curriculum, and where students are the active creators in the educational setting. In this way, TBL could serve as an example of the practice that embraces these principles.

Contemporary nursing education should be flexible and open to adjust to the challenges of modern pedagogical practices. According to McCurry and Martins (2010), millennial nursing students prefer innovative teaching approaches that include active learning assignments, reading quizzes, clinical nurse researcher presentations, and collaboration with clinical course assignments. Through innovative pedagogical strategies, educators give students a chance for active participation in the creation of a learning context where the educators are facilitators of their learning process. However, although these methods are centered and have many advantages compared to traditional lectures, some students identified undesirable consequences of these alternative approaches, such as an enormous amount of work and time commitment (Ward et al., 2018). The combining of these methods with traditional assignments could serve as a useful tactic. Therefore, teaching strategies should target discovering which subjects, themes, and assignments in nursing education could be transmitted more successfully with alternative approaches compared to traditional ones.

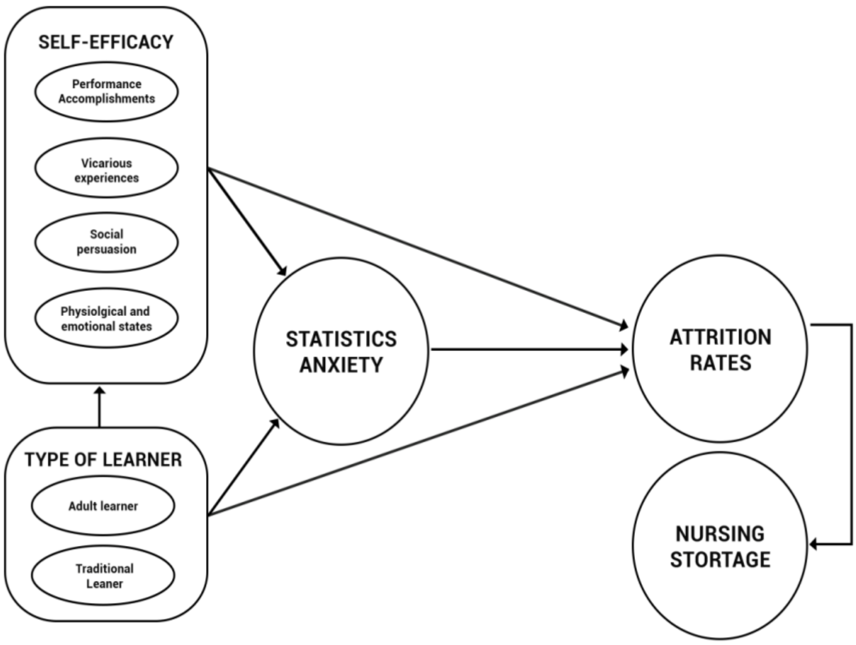
Conceptual Framework

The present investigation explores direct and indirect relationships between SA, SSE, and the specific types of learners in the context of a nursing program. For this study, a working conceptual model was developed, which identifies the relationships between SA, SSE, type of learner, attrition rates, and nursing shortages (see **Error! Reference source not found.**-1).

This model assumes that SSE elements (mastery experiences, vicarious experiences, verbal or social persuasion, and physiological or emotional states) and the type of learner relate to SA (Perepiczka et al., 2011). Accordingly, adult learners should report higher levels of SA and lower levels of SSE than traditional learners (Bui & Alfaro, 2011).

Figure 1.1

Conceptual Framework



Note: Conceptual model of the relationship between statistics self-efficacy, type of learner, statistics anxiety, and attrition rates in a nursing program resulting in nurse shortage.

Relative constructs concerning the theoretical framework for this POP include the social cognitive theory (Bandura, 1977) and andragogy (Knowles, 1980). These theories provide valuable insight into the various ways in which anxiety affects self-efficacy and academic success in adult learners.

Social Cognitive Theory and Self-Efficacy

The social cognitive theory features self-efficacy and human agency as its significant components. These two causal components enable human beings to acquire competencies and regulate their behavior (Bandura, 1977). In particular, self-efficacy pertains to an individual's belief in their capability to successfully perform a task based on experience and other antecedents. Therefore, the definition of self-efficacy may be the confidence people have in their ability to exercise control over three factors: personal and cognitive aspects, environment, and behaviors.

Elaborating more on the concept of self-efficacy, Bandura (1977) stated that the concept has four primary sources of influence through which a person acquires and maintains self-efficacy: "(a) performance accomplishments or mastery experiences; (b) vicarious experiences; (c) verbal or social persuasion; and (d) physiological or emotional states" (p. 23). Mastery experiences improve self-efficacy as prior success boost belief in one's competency, while failures weaken it. Moreover, vicarious experiences are those that enhance a person's self-efficacy through the influence of a role model. Additionally, verbal and social persuasion influence self-efficacy by strengthening a person's belief that they have the skills and attitudes necessary to accomplish a task (Bandura, 1977). Finally, individuals are dependent upon physiological or emotional states when judging their performance ability; people may interpret tension and stress as signals that they are about to perform poorly. Unfavorable moods, pains, and fatigue may also weaken a person's perception of their ability (Levett-Jones, 2005).

Self-efficacy may also have a direct connection to anxiety. Bandura (1977) asserted that there is an inverse relationship between anxiety and self-efficacy but that an individual is not as affected by only anxiety. Instead, people are affected by their interpretation of anxiety. McMullan et al. (2012) described Bandura's notion of self-efficacy by applying the oft-cited metaphor of having “butterflies in one’s stomach.” A person with low self-efficacy would consider butterflies a sign of their incapacity to do their work while a person with a high self-efficacy would perceive the sensation as a regular occurrence that does not relate to performance.

Bandura (1977) argued that what is genuinely significant are not the actions themselves, but rather our interpretation of beliefs concerning our capacity to determine our progress in any activity or endeavor. Moreover, these interpretations constitute what Bandura considers human agency and forms part of the social cognitive theory. In the context of students accomplishing their coursework, researchers discovered that students attribute feelings of reward or punishment when doing research methodology assignments based on their previous experiences (Shivy et al., 2003). Additionally, past failures or success in other statistics or mathematics-oriented courses would be influential in a student’s self-efficacy in a statistics course. Whereas past failures could diminish a person’s belief that they could pass a statistics course, previous success could boost belief in the individual’s ability. Overall, students’ beliefs in their abilities are associated with their earlier academic experiences, their current social support, and their ongoing academic success.

Andragogy

Knowles (1980) developed the theory of andragogy to describe a unified theory of adult learning wherein educators facilitate learning. By emphasizing self-direction, learners are responsible for their education. In the theory of andragogy, the most significant component of helping adults learn is a climate of physical comfort, mutual trust and respect, openness, and acceptance of differences.

The researchers, Knowles et al. (2005), made six assumptions regarding andragogy. First, there is an assumption that adults need to know why they should learn something. Once they establish this, educators could help learners understand the value of the education they are providing them and make connections they could relate to how knowledge is essential to their future. Second, andragogy emphasizes the importance of self-concept in the adult learner. As a person's self-concept increases, their personality shifts from dependence on others to autonomy. As a result, adult learners become capable of self-direction and could learn independently. Third, as people mature, they accumulate experiences that aid in the learning processes. Adults learn better when they could incorporate these experiences into the learning process. Fourth, adults' readiness to learn increases when the material concerns real-life problems. Adults are problem-oriented learners who want information that will help them solve a specific problem. Fifth, as the person matures, the orientation to self-learning shifts from subject-centeredness to problem-centeredness. Fifth, as a person matures, the motivation to learn shifts from externally-based to internally-stimulated. The learner is self-directed and takes responsibility for learning (Knowles et al., 2005).

The research on andragogy indicates that adult learners, aged 25 or older, may differ substantially from traditional university learners, aged 18–24. Therefore, it is crucial to consider that the effects of academic anxiety may manifest differently in adult student populations.

Overall, the theoretical framework for this study uses social cognitive theory (Bandura, 1977) and andragogy (Knowles, 1980). Together, these theories provide context for how SA and SSE may manifest in the adult nursing student.

Physiological Responses to Mathematics Anxiety

Anxiety has a wide array of physiological manifestations influencing a person's health, behavior, and cognition (Maloney et al., 2014). Additionally, mathematics anxiety could negatively impact a student's mathematics performance, eventually leading to avoidance of mathematics-related careers and fields (Artemenko et al., 2015; Maloney & Beilock, 2012; Maloney et al., 2014). Some of the physiological mechanisms by which mathematics anxiety emerges and impacts a student's performance and behavior include areas of the brain responsible for pain (Lyons & Beilock, 2012) and emotional regulation (Artemenko et al., 2015). Although no studies specifically investigated the physiological responses to SA, there was research regarding the physiological responses to mathematics anxiety. Accordingly, it was helpful to understand the biological mechanisms by reviewing neuroeducation and mind-brain education-based research to understand the impact that mathematics anxiety has on a student.

Researchers attribute various antecedents to mathematics anxiety and how it develops (Maloney & Beilock, 2012). Individuals may have predispositions and risk factors for developing mathematics anxiety that include negative attitudes concerning mathematics held by teachers, female gender, and related stereotype threats, as well as specific deficits in the fundamentals of mathematics (Maloney & Beilock, 2012). In their description of the relationship between anxiety and cognition, Maloney et al. (2014) described mathematics anxiety as a social construct that stems from the early development of negative attitudes toward mathematics.

Mathematics anxiety is often associated with test anxiety; therefore, research has focused on the distinction and similarities of test anxiety and mathematics anxiety, emphasizing the specifics of each construct (Artemenko et al., 2015; Maloney et al., 2014). According to Maloney et al. (2014), although it is clear that, unlike test anxiety, mathematics anxiety is a domain-specific construct, the mechanisms by which performance is affected in each of these phenomena are alike. The explanations about the mechanisms include theories about anxiety-induced physiological reactions that, in many ways, interfere with cognitive processing, especially working memory.

Anxiety causes psychological arousal that manifests in specific changes in our body. People may react to these changes differently depending on their motivational styles (approach or avoidance). Moreover, performance on a mathematics task will depend on the subject's interpretation of the given mathematics-related cue as a challenge versus a threat (Maloney & Beilock, 2012; Mattarella-Micke et al., 2011; Scholl et al., 2017). On the one hand, if a person sees a cue as a threat, they will respond negatively and thus anticipate failure. On the other hand, if a person sees a cue as a challenge, they will work even harder at solving the mathematics problems and perform better (Mattarella-Micke et al., 2011; Scholl et al., 2017).

Scholl et al. (2017) sampled 50 Dutch undergraduate students. Their study showed that the cardiovascular reactivity of the participants who found the mathematics task challenging (rather than threatening) correlated with better performance in a numerical task. Therefore, Scholl et al. advocated for positive feedback to mathematics students that would serve as a reappraisal of mathematics-anxiety induced physiological responses. By changing a person's perspective on the task difficulty and their ability to solve it, the student's performance could improve.

Sometimes, the anticipation of number processing could be enough to cause a negative affective response. An experimental study that sampled eighteen Chicago University students with different levels of mathematics-anxiety showed that high-mathematics anxious students experience the pain-related brain activity in the dorso-posterior insula and mid-cingulate cortex even in anticipation of mathematics task, not merely when they are doing it (Lyons & Beilock, 2012). This result may indicate that mathematics anxiety is grounded in aversive body reactions that happen when mathematics-anxious subjects encounter mathematics-related stimuli.

Additional studies show that other parts of the brain are also affected by mathematics anxiety. Emotional regulation, through which individuals react to anxiety, alters brain connectivity, and brain activity by influencing the amygdala, ventromedial, and dorsolateral prefrontal cortex (Artemenko et al., 2015). Maloney et al. (2014) explained that this could be a cause of performance failure. Solving a cognitively demanding task requires the activation of the same regions in the brain responsible for the control of the sympathetic nervous system (e.g., prefrontal cortex), which is increasingly active in situations of high physiological arousal. This fact may mean that fewer cortical resources become accessible for cognitive processing, which could be a cause of poor performance. Moreover, “high mathematics-anxious individuals show less efficient neural processing in numerical tasks and thus require more effort than low-anxious individuals to reach similar performance levels” (Artemenko et al., 2015, p. 5).

Moreover, worry and negative thoughts caused by anxiety influence a person’s working memory capacity (Maloney & Beilock, 2012; Mattarella-Micke et al., 2011), and individuals with high-working memory capacity suffer the most in these situations. Mattarella-Micke et al. (2011) conducted an experimental study of 73 students to further examine the role of working memory in the relationship between mathematics anxiety and mathematics performance.

The study demonstrated that high cortisol levels after the mathematics exam correlated with poor mathematics performance in mathematics-anxious participants who had a naturally higher capacity of working memory. The level of cortisol performance seemed not to affect mathematics-anxious participants who had a lower working memory span. Additionally, the individuals with a high-working memory span that was not mathematics anxious benefitted from the increase of cortisol, resulting in better performance, which indicated that they interpreted a task as a challenge. These findings provide evidence that poor performance in mathematics-anxious individuals may be a result of their negative emotional arousal, mediated by a working memory span. Those with a high-working memory span rely on complex cognitive resources for task processing; however, under the influence of the high emotional arousal, their ability is impaired.

Not only college students could have a physiological reaction to mathematics anxiety. Even first-grade children demonstrate different levels of mathematics anxiety and related hyperactivity in the right amygdala region when doing mathematics (Maloney & Beilock, 2012). Hunt et al. (2017) described how mathematics anxiety could cause stress and related physiological responses in primary school children when doing a mathematics task by conducting a mixed experimental study on 77 children from the United Kingdom (U.K.) ages 9 to 11. The children completed a self-reported mathematics anxiety survey as well as two sets of standard mental arithmetic problems, while the researchers took measures of their heart rate and blood pressure as behavioral indicators of stress. The analysis showed that with the increase of mathematics task complexity, the children’s blood pressure elevated, which correlated especially with self-reported mathematics anxiety. The findings indicate that mathematics-anxious students experience possibly harmful physiological reactions when encountering complex mathematics problems.

Researchers have shown that a reappraisal of anxiety is a useful strategy for alleviating mathematics anxiety. John-Henderson et al. (2015) investigated whether anxiety reappraisal strategies could serve to diminish the consequences of stereotype-threat that female mathematics students may feel by assessing mathematics anxiety that relates to physiological markers for stress. Their experimental study sampled 97 18–35 year-old female undergraduate students at the University of California Berkeley. The participants did the same mathematics test with different instructions: some that depicted stereotype-threat and some that did not. Additionally, the participants differed by whether or not the researchers gave them information about the positive impact of anxiety. The researchers measured the students’ level of cytokine Interleukin-6 (a marker of body inflammation that varies with stress) before and after the test. The results showed that the participants who did the test under stereotype-threat had the most benefits from anxiety reappraisal. While the participants who completed gender-biased tests had a significantly higher level of cytokine Interleukin-6. The results confirm the importance of the subject's interpretation of the test difficulties and provide further evidence of the physiological responses students experience due to mathematics anxiety.

Although there is evidence that mathematics anxiety causes more extensive performance failures in complex tasks, studies have also found evidence that it could also affect fundamental number processing (Artemenko et al., 2015). Researchers have identified several successful techniques for reducing mathematics anxiety, including expressive writing, reappraisal, reducing stereotype threat, and breathing techniques (Maloney et al., 2014). Additionally, applying the findings from neuroeducation could be beneficial. According to Artemenko et al. (2015), "by extending the cognitive and emotional control capacities within the frontoparietal brain network, high mathematics-anxious individuals may still compensate for the anxiety-related performance deficit" (p. 6). Maloney and Beilock (2012) advocated for the prevention of mathematics anxiety in students by identifying at-risk students and applying the evidence-based techniques for emotional regulation.

Overall, there is evidence of biological responses to mathematics anxiety. Neuroeducation and mind-brain research provide details of the physiological responses a student experiences due to mathematics anxiety. Students with high levels of mathematics anxiety experience pain-related brain activity in the dorso-posterior insula and mid-cingulate cortex (Lyons & Beilock, 2012). In addition to pain-related activity in the brain, students with mathematics anxiety experience changes in neural processing that relate to emotional regulation, specifically in the amygdala, ventromedial, and dorsolateral prefrontal cortex (Artemenko et al., 2015). Other physiological changes in response to mathematics anxiety include increases in cortisol levels affecting working memory (Mattarella-Micke at al., 2011) and an increase in blood pressure (Hunt et al., 2017). Altogether, these findings indicate that when students experience mathematics anxiety, they experience distinct physiological reactions.

Underlying Causes of Statistics Anxiety in Nursing Programs

Nursing schools and departments across the U.S. suffer from a decreasing number of nurse graduates and increasing attrition rates (Beacham et al., 2008). Researchers have calculated that the average attrition rates are as high as 50% among nursing students in baccalaureate programs, and 47% among associate degree students (Newton & Moore, 2009). The attrition rates are even higher among minority nursing students (Gardner, 2005) and nontraditional nursing students (Gilchrist & Rector, 2007).

High attrition rates in nursing programs create a public health concern because as health care needs grow in tandem with an aging population of patients with diverse health care needs. Moreover, the current workforce of nurses is too small to meet this demand. Producing a population of competent nurses is not currently possible due to high attrition rates (AACN, 2012). Unless this problem ends, a nursing shortage is imminent. Thus, it is vital to investigate the causes of increasing attrition rates in nursing programs and to understand what students experience to isolate the barriers students face on the pathway to success.

Nontraditional students are especially prone to high attrition (Rudel, 2006). The term *nontraditional students* refers to students who are 25 years or older and who enter university with diverse levels of academic ability and work experience (Jeffreys, 2007; Rudel, 2006). Studies showed that nontraditional students are at higher risk of attrition due to financial difficulty, employment burdens, and family responsibilities (Bednarz et al., 2010; Jeffreys, 2007). Another factor that contributes to higher attrition rates for nontraditional students is the lack of academic preparation in the mathematics-based subjects required to pursue college degrees, as many adult students arrive in higher education with the need for remediation (Rudel, 2006). Moreover, ethnically diverse students are also at higher risk of attrition as a result of added barriers, including cultural constraints, language difficulty, lack of faculty guidance, academic ability, and feelings of isolation (R. C. Harris et al., 2013; Kennedy et al., 2008).

As the demands of the nursing profession grow, employers expect nursing students to have a working knowledge of statistics to utilize clinical research involving statistics so that they apply evidence-based practices better in hospitals and health care institutions. Competency in statistics is a crucial component of the scientific method, useful in improving professional knowledge in all academic disciplines, especially the health sciences (Davenport et al., 2007).

Several studies involving graduate social sciences students reflected that between 75% to 80% of social science graduate students experienced SA, leading to poor learning outcomes (Onwuegbuzie & Seaman, 1995; Onwuegbuzie et al., 2000). In fear of doing poorly in statistics, students with SA often either delay taking statistics courses or drop out of the program. Compared to mathematics anxiety, SA is relatively under-researched (Onwuegbuzie et al., 2000). While there have been studies that investigated SA, these have focused mostly on social science and education disciplines. For the studies that do exist, they have mentioned that several factors contribute to SA, especially student characteristics and SSE levels. Central to the study of SA are students' SSE or confidence in their ability to learn and understand statistics (Onwuegbuzie & Wilson, 2003).

Additionally, knowledge and application of statistics and statistical representation are imperative in nursing. Moreover, it is vital to consider the importance of evaluating and applying evidence-based nursing research in contemporary nursing (Bull, 2009). Nursing practice requires precision in mathematical application, particularly when administering medication, monitoring the balance of fluids, calculating intravenous concentrations, and recording, measuring, and evaluating nursing observations (Bull, 2009). Research indicates that many nursing students fare poorly in mathematical calculations, especially those involving drug dosages (Glaister, 2007). Generally, the lack of mathematical and statistical acumen among nurses could lead to medical errors, thereby compromising the safety of patients. As a student, the nurse clinician gains an initial level of calculation competence of safe dosages when administering medications. However, the various factors that allow drug calculation errors include mathematics anxiety, lack of confidence, and lack of numeracy skills (Andrew et al., 2009). Therefore, the ability to use numbers in the numerical sense through mathematical and statistical procedures is an essential clinical nursing skill.

Since statistics is one of the least popular and most feared subjects among nursing students, Onwuegbuzie and Wilson, 2010 explored the relationship between SA, SSE, attrition rates, and learner type among traditional and adult nursing students in a Southern California university nursing program requiring a statistics course for completion. The conceptual model for the study showed a possible relationship between SA and SSE and its contribution to the attrition rates in nursing programs, which exacerbates the existing nursing shortage. The results illustrated that this relationship differs in adult students compared to traditional learners.

Problem of Practice Literature Review

This literature review provides information on SA and how it leads to problems among registered nurses as well as nursing students. This review considered the unique needs of adult learners and reviewed literature that investigates the role of self-efficacy and anxiety in learning outcomes, primarily in the area of mathematics, specifically statistics. The student investigator explored the relevant literature between February 2016 to April 2016. She repeated the search between July 2016 and January 2017. Furthermore, she conducted her searches using the following databases: EBSCOHost, ERIC, PubMed, and Proquest. Search terms, including *math anxiety, statistics, self-efficacy, nursing, adult, and college*, using all fields (including title, abstract, keywords, and full text), and all study types of peer-reviewed journals.

Self-Efficacy

Defining Self-Efficacy

Self-efficacy refers to an individual's belief in their capability to accomplish certain tasks or succeed in specific situations (Onwuegbuzie, 2000). According to Bandura's (1986) self-efficacy theory, self-efficacy beliefs influence performance; therefore, positive encouragement and constructive feedback may improve student morale, increasing a student's confidence to sufficiently improve their abilities. Conversely, SA perpetuates if students do not succeed as they do not believe that they can improve their performances. Therefore, taking steps to improve the self-efficacy of students may decrease anxiety and increase student achievement in mathematics-based statistics courses.

Self-Efficacy in Academics

In Ainscough et al.'s (2016) study of 614 high school, middle school, and college science students, they set out to determine whether student self-efficacy in a biology course could increase over the semester. By the end of the semester, the results indicated that 81.1% of the students experienced increased levels of self-efficacy, with only 16.1% reporting negative changes. Of the high-achieving students in the course, 24% showed self-efficacy levels that indicated inaccurate judgments of their ability to do well in the course. Forty percent of the low-achieving students had inaccurate self-efficacy judgments. The researchers also observed a gender effect in the study: Overall, female students were less confident than male students. In particular, the high-achieving females were more likely to underestimate their academic abilities compared to other females as well as high and low achieving males. The participants in this study were biology students in middle school, high school, and college courses. Therefore, these results may not be generalizable to statistics students in college courses. However, overall, this study does provide evidence that self-efficacy may differ across groups of students and may change over a semester.

In mathematics courses, educators have found students' self-efficacy to vary across learning tasks. In Bernacki et al.'s (2013) study of 107 ninth graders in an algebra class, students' ability to solve mathematics problems impacted self-efficacy. Furthermore, this quasi-experimental study investigated the relationship between a mathematical test and self-efficacy; the results indicated that in the learning process, students' have a reduction in self-efficacy. Accordingly, the accuracy of self-efficacy predictions during prior performances is the most significant predictor of self-efficacy judgments, but the accuracy of self-efficacy predictions decreases over time.

Additionally, increases in self-efficacy during one period of learning mathematics tasks improved learning in the next period (Bernacki et al., 2013). Bernacki et al.'s study utilized first-year high school students in general mathematics courses, which may differ from the experiences of college students in a statistics course. However, these results do support the conclusions made by Ainscough et al. (2016) that self-efficacy levels can vary over time. As a result, researchers have concluded that in some mathematics and science subjects, self-efficacy levels can impact academic achievement and overall learning.

Individuals with higher levels of self-efficacy tend to view problems as challenges rather than as threats. A study that Pekrun et al. (2002) conducted, reviewed five qualitative articles that related to the development of the Academic Emotions Questionnaire. They reviewed seven cross-sectional studies, three longitudinal studies, and one diary study; the results indicated that students with high levels of self-efficacy protect other students from the adverse effects of peer pressure or overly-negative self-perception. Therefore, there may be an essential interaction between self-efficacy beliefs and student attitudes that also influences learning. These findings tie into Bandura's (1977) theory of self-efficacy as they illustrate that the effect of peer influence may contribute to changes in anxiety and self-efficacy levels. Furthermore, this study demonstrated some ways that relationships change self-efficacy with peers in a classroom setting. These results may provide some evidence as to how self-efficacy changes over a semester, as indicated by Ainscough et al. (2016) and Bernacki et al. (2013).

Another manner in which self-efficacy may relate to learning, is that higher self-efficacy reduces stress in individuals, improving their focus in class as a result. Pajares and Miller (1994) conducted a self-efficacy survey with 350 undergraduate students to explore the relationship between levels of self-efficacy and performance. The results indicated that when the students solved mathematical problems that corresponded with various levels of the individual's confidence, there was a positive correlation between the level of self-efficacy and performance on the tests. These results support findings by Bernacki et al. (2013), which stated that self-efficacy affects academic performance.

Additionally, levels of self-efficacy in adult learners were higher than in traditional learners (those between the ages of 18–24), possibly because adult learners possess a greater motivation to learn and are problem-oriented (Pajares & Miller, 1994). Furthermore, the results indicated that self-efficacy in mathematics subjects is linked to academic outcomes, including performance on tests, and may affect adult learners differently from traditional students. Therefore, following these results, it could be hypothesized that the performance of adult learners in mathematics-based classes, like statistics, would also be higher than that of the traditional college student.

Self-efficacy may relate to academic performance based on how students focus their efforts. Students with low self-efficacy tend to decrease their efforts following inevitable setbacks or failures, indicating that attitude and self-efficacy may be linked. Ahmed et al. (2012) conducted a semester-long study in two schools in the Netherlands over three occasions with 495 seventh-grade students. The study demonstrated that by the third test, the students who did well on the first two tests not only had higher self-efficacy but also performed better. Like Ainscough et al. (2016) and Bernacki et al. (2013), this study examined self-efficacy in middle school students and found that an individual's beliefs about their self-efficacy could increase over time in this population. This study provided evidence that self-efficacy could change over the semester, probably because success often contributes to the personal efficacy of students. However, failure undermines self-efficacy levels.

Additionally, a student's previous success may impact self-efficacy levels. Success creates a higher sense of efficacy, contributing to lower levels of stress and anxiety, and ultimately contributing to better performance (Finney & Schraw, 2003). Therefore, if a student continuously attains improving grades, there is a better chance that the student will continue to perform better. In the study conducted by Finney and Schraw (2003), they created two instruments to assess the SSE of students. The researchers validated the instruments using the SSE of the students as the primary predictor of overall success in statistics classes.

Furthermore, the authors hypothesized that these results could attribute to how self-efficacy compensates for poor prior knowledge. This hypothesis is consistent with the conclusions by Ahmed et al. (2012), who recognized that previous success and failures may impact a student's self-efficacy. Consequently, students with the same baseline knowledge could expect to have different performance levels due to the effect of self-efficacy on performance. This outcome supports the findings that self-efficacy affects academic performance (Ahmed et al., 2012; Ainscough et al., 2016; Bernacki et al., 2013; Pajares & Miller, 1994; Pekrun et al., 2002).

Overall, the research supports an intrinsic connection between self-efficacy and performance in statistics. Moreover, self-efficacy levels may differ across demographics and vary over time (Ainscough et al., 2016; Bernacki et al., 2013; Pekrun et al., 2002). Overall, high levels of self-efficacy produce better performance in statistics-related courses (Ahmed et al., 2012; Ainscough et al., 2016; Bernacki et al., 2013; Finney & Schraw, 2003; Pajares & Miller, 1994; Pekrun et al., 2002). Past experiences and prior expectations may affect how students perceive their competency in mathematics (Ahmed et al., 2012; Finney & Schraw, 2003). Thus, it is crucial to investigate the factors affecting self-efficacy, anxiety, and attrition. As noted in the conceptual framework, SSE may relate to the primary factors impacting SA, including attitude, expectations, performance, history and self-concept, fearful behavior, and general anxiety.

Influence of Self-Efficacy on Statistics Performance

Research indicates that higher levels of SA attribute to lower levels of SSE in individuals given that SSE plays a significant role in student performance in statistics and other related courses. In a study of 146 education majors in a graduate-level research methods course at a small, mid-Southern university, Onwuegbuzie (2000) found that individuals with low perceived self-worth had elevated anxiety levels, which negatively affected their academic performance. The results showed a positive correlation between self-efficacy and performance. Moreover, canonical correlation analysis revealed that students with low self-efficacy had significantly higher levels of SA subscales, specifically on measures regarding the worth of statistics, interpretation anxiety, computational self-concept, fear of asking for help, and fear of the statistics instructor (Onwuegbuzie, 2000). Therefore, SA may have an indirect relationship with SSE.

In a related study exploring the relationship between SA and SSE, Galla and Wood (2012) found that anxiety levels immediately rise after schools expose students to science, technology, engineering, and mathematics (STEM) subjects. These researchers analyzed quantitative data from a sample of 139 elementary school students and found that excessive anxiety significantly impaired academic achievement. The results indicated that anxiety negatively affects mathematics test performance for students with low levels of self-efficacy, and they identified self-efficacy as a moderating variable. Anxiety did not affect those students' test performances who had high levels of self-reported self-efficacy. The participants in this study were elementary students, so the results may not be generalizable to college students. However, this study did provide evidence that self-efficacy may influence levels of anxiety, which in turn may result in changes to student performance in STEM-based subjects, including statistics.

Evidence suggests that self-efficacy influences the perceptions and attitudes of individuals concerning statistics-related courses, consequently affecting student performance. Therefore, finding ways to raise the level of SSE in students may alter SA as a result.

Mathematics Self-Efficacy in Adult Learners

A growing body of literature has examined mathematics self-efficacy, specifically in adult learners. By focusing on the differences between adult and traditional mathematics students, researchers have found that adults use distinctive metacognitive strategies for learning (Hollis-Sawyer, 2011; Lemaire et al., 2004).

Self-efficacy and anxiety may relate to student metacognition levels in mathematics. A study conducted by Lemaire et al. (2004) compared the computational abilities of 30 young adults (aged 30 or younger) and 30 older adults (over 30 years old) using four different sets of tests. The student investigator recruited traditional students from the University of Provence in France and the adult students from the community. Additionally, the student investigator matched traditional and adult students based on the number of years of formal education, arithmetic fluency, and self-rated health. The experiment used 144 multiplication problems as stimuli. Overall, adult students exhibited weaker computational skills, and they were less accurate and slower in solving involved and complicated problems. Moreover, traditional and adult students accomplished cognitive tasks in mathematics in different ways, indicating that the ideal teaching and learning strategies may be different for students of different ages, especially in mathematics-related tasks.

Moreover, adjusting diverse teaching strategies to students of different ages is significant because older learners come to class with certain preconceptions regarding their abilities. In a study conducted at a large, diverse Midwestern university, Hollis-Sawyer (2011) investigated if a stereotype threat affects the math ability and performance of nontraditional older college students. The sample consisted of nontraditional male and female students aged 40 to 72 (n=53). The student investigator selected traditional, younger students aged 18 to 29 as a control group (n=67). Each of the students recorded their time estimate for studying the mathematics skills manual, while the student investigator measured the actual time needed for learning. Additionally, the student investigator asked the participants about the metacognitive strategies they use for learning and recorded their answers.

Hollis-Sawyer (2011) administered a mathematics performance quiz, as well as a personality test. The results were that, although there were no significant math performance differences, nontraditional, older college students had a higher level of math anxiety and a lower level of self-efficacy. This outcome contradicts the findings by Lemaire et al. (2004), who suggested that adult students would require more time to solve mathematical problems. However, a discrepancy between the older students' self-appraisal and their performance linked to less effective metacognitive self-awareness among older learners in mathematics courses.

Although the personal characteristics of learners are essential for mathematics self-efficacy, external factors could also have a significant effect. One of the factors that could influence the adult student's mathematics self-efficacy is classroom climate. Peters (2013) recruited instructors (n=15) and their students (n=326) from various universities in the U.S. for a study investigating the relationship between teaching style (teacher-centered versus learner-centered) and mathematics self-efficacy. While the teaching style did not affect the students' mathematics performance, the results indicated that students with higher levels of mathematics self-efficacy had instructors who implemented a teacher-centered approach. These results aligned with those from Hollis-Sawyer's (2011) study that found adult students have different learning styles from traditional students, which impact mathematics self-efficacy levels.

Other studies highlighted the benefits of the learner-centered approach in mathematics learning. The motivation for learning mathematics is one of the causes of the learner's success and self-efficacy, and applying a learner-centered approach could stimulate it. Irvine (2019) conducted a qualitative study that sampled 13 adult students from a community college in Canada, which highlighted the importance of affective components (positive and negative attitudes toward mathematics) in determining students' success in the course. All of the participants were in a mathematics course that accentuated the practical application and utility of mathematics for their future business careers. The instructor used various strategies to encourage the participants to discuss the course-related problems and aimed to transmit a positive attitude for mathematics to students. Additionally, they facilitated the collaboration between students and positive social interactions. The researchers evaluated the students' disposition toward mathematics by assigning each one an affective vector triple consisting of the level of mathematics motivation, learning mathematics anxiety, and exam mathematics anxiety.

Additionally, Irvine (2019) used content analysis, observations of verbal and non-verbal cues, quizzes, and the exam to evaluate the course effects. While students were initially anxious and mathematics-phobic, the instructors motivated the students to become engaged in the class by a collaborative and risk-free environment. Consequently, the course design had positive impacts on student attitudes and student learning. This outcome supports the research conducted by Peters (2013), who found that adult learners may benefit from a learner-centered approach in mathematics.

Overall, mathematics self-efficacy is equally crucial for adult students' motivation to learn mathematics as it is for their performance. Mathematics instructors should implement different strategies promoting mathematics self-efficacy, considering the specific metacognition levels, motivational aspects, and learning styles of adult learners.

Mathematics Self-Efficacy in Health Care Students

Many students tend to avoid mathematics or perform poorly due to mathematics anxiety. Mathematics avoidance occurs when students fear mathematics subjects and engage in behavioral inhibition. In a study of 184 undergraduate students from a large public university, Liew et al. (2014) discovered a positive correlation between mathematics test anxiety and avoidance temperament. These results align with the outcomes that Galla and Wood (2012) obtained in their study of elementary children, indicating that the relationship between self-efficacy and student performance may persist from elementary through a college education. As a result, students with mathematics anxiety may avoid taking mathematics classes, ultimately restricting their qualifications for various careers. As a result, mathematics anxiety may influence a student's achievement, as well as educational and career goals. Since statistics is a branch of mathematics, students may expect a similar result with that subject matter.

Employers expect nurses to use mathematics in their clinical work, calculating dosages of medications in accordance with patients' weights. Consequently, nursing programs require several mathematics classes as part of the curriculum. As such, the nursing population may have unique experiences with mathematics anxiety.

In a study of 229 second-year British nursing students, McMullan et al. (2012) explored the influence of mathematics anxiety on self-efficacy and found that strong significant relationships exist between anxiety, self-efficacy, and ability. Participants who failed either numerical or drug calculation ability tests were more anxious and less confident when performing calculations compared to those who passed the tests. Furthermore, those participants who failed a numeracy test were less confident in performing drug tests, indicating that high levels of anxiety and low levels of self-efficacy negatively affected their work. As a result, if a nurse has difficulty in accurately performing drug calculations, it may be due to poor numerical skills, anxiety concerning learning mathematics, or a general lack of confidence in mathematics skills (McMullan et al., 2012).

Overall, there is an inverse relationship between anxiety and self-efficacy. McMullan et al.'s (2012) study posited that a person's interpretation of the presence of anxiety may influence their self-efficacy level more profoundly than by the presence of the anxiety response. They provided evidence that mathematics anxiety relates to mathematics self-efficacy and clinical ability in nurses. This ties into the conclusions made by Liew et al. (2014) that mathematics anxiety may impact the types of careers for which students are qualified and may affect educational and career goals.

Additional studies emphasized the relationship between mathematics self-efficacy and the future career of the students. For example, Farmer and Chung (1995) conducted a study at a large Midwestern university using 100 students aged 18 to 24 enrolled in an introductory psychology course. The participants completed a questionnaire investigating whether mathematics self-efficacy, effort, and the value attributed to mathematics/science, could predict career motivation aspects. The results of the regression analysis showed that valuing mathematics/science was one of the most significant predictors of the value a person places on a career, as well as of a subject's willingness to pursue challenging and difficult tasks. This finding is in alignment with the results that Liew et al. (2014) obtained, where they found that there is a relationship between mathematics anxiety and career avoidance behaviors. Therefore, the results obtained by Farmer and Chung demonstrate further that it is significant to emphasize the practical utility of math and science in different careers. Even though there was a lack of a relationship between mathematics self-efficacy and career motivation, Farmer and Chung suggested that researchers continue to measure and refine mathematics self-efficacy.

Learner-centered curriculum design may also benefit nursing students' self-efficacy, as well as their numerical abilities, highlighting the importance of attaining numerical skills for nursing practice. Gregory et al. (2019) conducted a pre- and post-test quasi-experimental cohort study by sampling 715 undergraduate first-year nursing students at a single multi-campus university in the Western Sydney region of Australia. Their goal was to examine the nursing students' mathematics self-efficacy and their numerical abilities. Participants in the study were in a mathematics course where the educator utilized a three-step pedagogical approach of numeracy. The educator gave the students a theoretical foundation on the topic, while the students applied their knowledge in the clinical context.

The results yielded three significant findings. First, before the course, high mathematics self-efficacy significantly related to the male gender and previous math knowledge. Second, the high level of mathematics self-efficacy positively correlated with numerical abilities and mathematics performance. Third, there was a significant increase in mathematics self-efficacy over the course, demonstrating that a carefully designed curriculum could be valuable to nursing students by improving their confidence and competence in medication administration. The results obtained by Gregory et al. (2019) support the findings by McMullan et al. (2012), who identified the effect of mathematics self-efficacy on nurses' clinical abilities that primarily relate to drug dosage calculations. Furthermore, these results are in alignment with the research conducted by Peters (2013) and Irvine (2019), who found that applying a learner-centered approach in mathematics could improve a student's self-efficacy.

In another analysis, Cheema and Galluzzo (2013) used 4,733 observations from the Program for International Student Assessment's (PISA) 2003 questionnaire. They sought to determine the impact of mathematics anxiety on self-efficacy across different demographics, such as gender, age, race, and socioeconomic status. While they did not identify reliable indicators of demographic gaps, the survey conveyed that self-efficacy was significantly lower among participants experiencing mathematics anxiety. The results of the study suggest that some of the variations they observed showed that anxiety and self-efficacy mediate mathematical achievement indicators between genders. When the researchers could control for the effect of anxiety and self-efficacy, the gender gap in mathematics achievement disappeared. Thus, understanding the academic effects of anxiety and self-efficacy may help explain why some students struggle with and drop out of mathematics-based classes, like statistics (Liew et al., 2014).

The research on self-efficacy indicates that it affects the learning processes, thereby impacting student performance levels. The perceptions and attitudes of a statistics student may be tied to the student's self-efficacy levels and could impact the student's performance and grade in the class. Consequently, it is vital to consider the effect that self-efficacy may have on anxiety and achievement for statistics students.

Type of Learner

Andragogy is a field of study that explores the different ways in which adults learn and are motivated (Adler & Clark, 1991; Jin & Rounds, 2012). Adult learners are those 25 years and older (King et al., 2003; Spitzer, 2000). Over the past several decades (from the late 1990s to the present), there has been an increase in adult learners, which in turn has created a need to address adult learners' experiences in depth (Spitzer, 2000; Mezirow, 2002).

Several factors contribute to the rising numbers of adult students, including changes in demographics, the introduction of new technology, and the need to keep up with the current trends in pedagogy (Solomon, 2007). In Schunk's (1991) systematic literature review, he found evidence that the majority of the adults returning to school to advance their education did so due to changing factors, such as the need to learn new technology. Such changes impact the adult student's self-efficacy, ultimately affecting outcomes, including academic motivation. Given this, it is critical to understand the motivating factors for adults returning to school since their experiences are significantly different from traditional students' experiences.

Adult education is necessary at various junctures in an individual's life. For example, a 21 year-old individual may change jobs at least seven times in the course of their lifetime. Aslanian and Brickell (1981) conducted a historical study consisting of a national representative sample of 2,000 American adults, age 25 or older, who had returned to school. One of this study's goals was to understand the rapid demand for adult learning. The results indicated that over 56% of the participants returned to school in anticipation of a new career, while 36% of them indicated that they had returned to school due to family events. Moreover, some respondents returned to school due to the death of a loved one or a divorce. This study indicates that as far back as 1981, adults were returning to college, which resulted in a change in demographics at the university level (Aslanian & Brickell, 1981).

As people age, they tend to lose their speed of learning; however, research indicates that intellectual ability remains intact. Renk and Smith (2007) gathered data from 93 undergraduate students enrolled in a psychology class at a large Southeastern university using self-reported questionnaires. The results indicated that anxiety, problem-focused coping, and support from significant others were the strongest predictors of academic stress in the students. Furthermore, the researchers found that as people age, the ability to learn slowly degrades. As such, there may be substantial differences in learning between adult students and traditional students. Therefore, finding the solutions to academic anxiety and self-efficacy may create the potential to influence the choices of many students regarding statistics courses (Renk & Smith, 2007).

The research discussed in this chapter supports the notion that traditional students and adult students may have substantial learning differences, including diverse factors that motivate them. Therefore, how SA manifests in adult students may be different from what educators commonly observe in traditional students.

Prior Knowledge

As mentioned previously, several factors exist that may affect adult learning. In their book *Learning in Adulthood*, Merriam and Caffarella (1999) explained that increased job satisfaction, self-esteem, and quality of life are factors most likely to motivate adults to attend college. The authors claimed that adults' personal life experiences have already educated them. Therefore, the reservoir of experience that an adult accumulates could serve as a fertile resource for learning (Merriam & Caffarella, 1999). Such a finding indicates that adults may learn in ways that differ from traditional students.

Most adults have had prior school experience, and therefore, may be *dependent learners* who must break old habits to become self-directed learners (Cercone, 2008, p. 137). Research conducted by Cercone (2008) summarized adult learning theories, especially as they relate to online learning communities, which may be new to adult students. Cercone's findings showed that educators taught most adults in a traditional, passive classroom. Thus, making it difficult for these students to adapt to online, hybrid, collaborative, and flipped classroom settings. In most cases, however, the need to acquire knowledge to solve various problems prompt adult learning.

Furthermore, these adult learners place a higher value on time and tend to avoid pursuing some of the college majors and specific courses within those majors that they deem irrelevant (Cercone, 2008). Additional research indicates that adults may learn differently and invest their time in diverse ways. In his article about the principles of adult learning, Lieb (1991) mentioned that adult learners are goal-oriented and need to see its relevance to learn a subject effectively. Lieb also noted that adult learners are more time-conscious as compared to traditional learners in college. Again, adult students typically accumulate life experiences and knowledge from work, family experiences, and past education (Lieb, 1991). This research aligns with the research conducted by Cercone (2008) and provides additional evidence that adult students may learn and invest time in different ways than traditional students. Additionally, it suggests that some motivating factors for adult learners include personal and career factors.

Adult students may differ from traditional students in the way they enhance their self-identity from their past experiences. Kasworm's (2005) study of 28 students at two community colleges used purposive sampling techniques and collected data through semi-structured interviews with a demographic questionnaire. The results indicated that the cultural and social experiences of the adult students (aged 30 or older) differed from those of the traditional-aged students (between the ages of 15–29). All of the adult students included in this study believed that their positive attitude toward aging influenced their learning performance. Moreover, they tied their self-efficacy to their efforts instead of their cognitive abilities, attributing their academic success to the idea that they worked harder than traditional students. Therefore, the identity, motivation, and experiences of adult students may differ from traditional students, ultimately affecting outcomes such as academic performance.

Past experiences, however, may also hinder the acquisition of new knowledge because of old ways of thinking and the persistence of old habits (Polson, 2003). Also, not all the experiences that adult learners bring with them are relevant within the learning context. For example, Polson (2003) found that in some cases, adults overgeneralize from their experiences. If the experiences in an adult's life do not apply to what they study in school, they do not see the value in learning the information. Moreover, some prior experiences may be detrimental and could negatively influence the learning process as a result. For instance, previous failures may create the expectation of failure, which could contribute to future failures or avoidance due to fear of failure (Polson, 2003). Given these challenges, adults may sometimes need additional accommodations for success in their learning context.

Fear of failure due to past learning experiences may be especially applicable to adult nurses. In his article on the theories that could apply to the teaching of adult nurses, Draves (1984) concluded that if an adult nurse continually performed at a low level in a specific subject, that student may avoid taking that subject, fearing future failures. Additionally, if that adult student chose to take a class in a similar subject, they could have further difficulty learning the material due to their preconceived ideas, contributing to higher levels of anxiety and stress (Draves, 1984). As a result of these predispositions, adult nursing students may choose to avoid classes in which they experience anxiety due to a fear of failure.

The motivation to learn varies from one individual to another. According to Knowles (1980), as adults develop, they change from being full-time learners to students with other responsibilities. For this reason, the individual becomes self-directed, capable of balancing a variety of responsibilities and obligations simultaneously. Adult learners are often more problem-oriented and motivated by different factors when compared to traditional learners in college (Knowles, 1980). This difference provides more support for how adult learners differ from traditional students.

Additionally, adult learners connect their professions to their self-identities, which significantly affects how they learn inside and outside of their professional context. A study conducted by Solomon (2007) found that anxiety affects the ability of students to concentrate in class, which generally leads to a lower level of understanding. Interviews with 12 first-year undergraduate mathematics students between the ages of 19–34 at an English university found that among adult learners (those aged 23 years and older), the sense of identity and a feeling of community have the potential to influence a students' choices and could potentially increase enrollment and decrease attrition. Subsequent results indicated that mathematics students with anxiety typically felt like outsiders and failed to realize that other students shared a similar sense of anxiety and fear. Such results further support the claim that anxiety, self-efficacy, and achievement may each be interrelated and yet may differ substantially for adult learners when compared to traditional students.

Studies of adult learners in mathematics classes have shown that self-direction is influenced by previous or current classwork, as well as by past experiences (Jameson & Fusco, 2014). A study comparing 66 traditional learners (aged 18–22) and 166 adult learners (over age 23) using a quasi-experimental design found that the adult learners performed better when tested on topics for which they could find general life applications, such as decimals and fractions, compared to abstract topics, such as geometry and trigonometry. These results indicated that as individuals mature, they increasingly tend to focus on self-selected topics for which they attribute the most value in their personal and professional lives. The self-directed nature of their learning distinguishes adult learners from traditional students, and it further suggests that differences may exist between the expectations of adult learners and traditional students.

A qualitative study conducted by Usher and Pajares (2008) found that individuals attend school for various reasons, among them, the improvement of their self-image, which acts as a source of self-efficacy. One noteworthy factor of this research is that if someone spends time away from academia, something stronger must drive them to enroll in college than what drives a traditional learner (Usher & Pajares, 2008). This motivation may explain why some older adults are more willing and readier to learn as compared to traditional students.

When conducting a review of the available literature on sources of self-efficacy, Usher and Pajares (2008) found that when people were aware of the benefits of what they were learning and had an optimistic outlook, they more easily acquired new knowledge. The results from Usher and Pajares align with the conclusions from Jameson and Fusco (2014), who identified the motivation and value with which adult students place on their education. This study also expanded upon Knowles' (1980) findings that adults must understand why they are learning and why the educator is covering the given material in the course, to invest themselves in the content.

Adults approach formal education with different life experiences than those of traditional students. These individuals may have families and jobs and may even be returning to education to change their degree. Therefore, understanding how instructors could integrate students' prior knowledge into the learning experience could be valuable for the student and the educator.

Attrition Rates in Adult Learners

Anxiety levels of adults may have more far-reaching consequences than those of traditional learners because adult learners must often tackle other stresses—such as working full time and maintaining a household—in addition to the standard academic stress experienced by traditional students (Hardin, 2008). Therefore, when these adult students become overwhelmed with competing priorities, they often feel as though their only available option for recourse is to drop out of the program. Consequently, it is imperative to identify why adult learners drop out of programs that traditional students do not.

For adult learners, age and academic ability relate directly to attrition rates (Dirkx & Jha, 1994). In a retrospective study conducted by Dirkx and Jha (1994), they attempted to understand why some adult students complete their studies while others do not. The authors obtained information from a community college located in a mid-sized Midwestern community. Using data from 2,232 students enrolled between 1988–1990, Dirkx and Jha found that entry-level mathematics, reading scores, and participant age effectively predicted completion rates. In this study, the researchers obtained results using discriminant analysis that indicated that younger students were less likely to complete their degrees than were older students. In particular, students at the age of 21 had the lowest completion rates, and students over the age of 25 had the highest completion rates. Furthermore, those who had several years of prior education were more likely to persist in the program. This fact may be an indication that attrition rates differ based on the age of the student.

Significant findings on the type of learner indicate that adult students and traditional students may have different intellectual needs based on age and life experience (Renk & Smith, 2007; Schunk, 1991; Solomon, 2007). Past experience, prior knowledge, and emerging technology may influence the academic abilities and attrition rates of adult students (Cercone, 2008; Kasworm, 2005; Lieb, 1991; Merriam & Caffarella, 1999; Polson, 2003). As a result, adult learners may benefit from different pedagogical methods for educators to use to engage and motivate them in the classroom (Draves, 1984; Jameson & Fusco, 2014; Knowles, 1980; Usher & Pajares, 2008). There may be other factors that contribute to the attrition rates distinctive to the adult learner population, which do not apply to traditional students (Dirkx & Jha, 1994; Hardin, 2008). Therefore, it is necessary to recognize the unique needs of adult students and provide sufficient support in the appropriate context.

Statistics Anxiety

Defining Statistics Anxiety

Zeidner (1991) gave a comprehensive definition of SA by defining the phenomenon as:

> A performance characterized by extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal … when exposed to statistics content, problems, instructional situations, or evaluation contexts, and is commonly claimed to debilitate performance in a wide variety of academic situations by interfering with the manipulation of statistical data and solution of statistics problems (p. 319).

A student with SA has difficulty analyzing and interpreting statistical findings and comprehending graphs, tables, and other statistical concepts as well as understanding research articles (Onwuegbuzie, 1997). For undergraduate nursing students, understanding graphs, tables, and charts, as well as understanding research articles, is essential for them to interpret the findings and apply them to particular nursing scenarios. Moreover, SA prevents individuals from fully understanding the results section of a research article and threatens to prevent them from making hypotheses or interpreting research data appropriately (Onwuegbuzie, 1997) .

The pervasiveness of SA constitutes a problem affecting a sizable population of students. Many students identify their statistics courses as among the most anxiety-inducing in their entire program (Zeidner, 1991). In Onwuegbuzie's (2000) research, students reported higher levels of anxiety in statistics courses as compared to other classes. His study looked at 146 graduate students enrolled in a research methodology course in an education discipline at a small mid-Southern university. The results indicated that the students with the lowest levels of perceived intellectual ability had the highest levels of SA, especially as it related to the perceived value of statistics, interpretation anxiety, exam anxiety, fear of asking for help, and fear of statistics instructors (Onwuegbuzie,(2000).

Interestingly, SA does not relate to perceived job competence. This lack of relationship aligns with Malik's (2015) research findings that students with high levels of SA experience higher fears of failure and are more likely to withdraw from the course. Such findings suggest that students with high levels of SA may choose careers in which they do not anticipate the use of statistics.

Students with SA experience anxiety whenever their instructor exposes them to a situation involving statistics; therefore, SA refers to a habitual and enduring type of anxiety (Onwuegbuzie, 2004; Onwuegbuzie & Daley, 1999). For this reason, SA is a persistent academic problem across all fields of the discipline.

The Relationship Between Statistics and Mathematics Anxiety

Malik (2015) conducted a phenomenological study investigating the underlying factors and circumstances leading to negative experiences in statistics among college students. This study followed six undergraduate students enrolled in an introductory statistics course. The participants were from different fields of study, including nursing and psychology, and were aged 18 years and older. The phenomenological study used a methodological approach measured by the Students' Statistics Anxiety Scale (SSAS) to carry out a purposeful sampling of participants with high levels of SA. According to Malik's findings, particular situations induce SA among students. Factors that potentiate SA include feelings of inadequacy, physiological symptoms, and the students' inabilities to conceptualize statistical symbols and terminologies. Based on these themes, Malik developed a SA model of phenomenology that indicates students give up when they have high SA. Consequently, understanding the factors that relate to SA may help explain why students drop out of academic programs.

Extensive research on the principal aspects of anxiety in college students, especially in mathematics and statistics education, has led researchers to understand that mathematics anxiety and SA are two distinct phenomena (Maloney & Beilock, 2012). In general, they define SA as “the feelings of anxiety encountered when taking a statistics course or doing statistical analyses” (Cruise et al. , 1985, p. 92). As such, the definition of statistics is different from that of mathematics anxiety. Experts define mathematics anxiety as “the feelings of anxiety, dread, nervousness, and associated bodily symptoms that relate to doing mathematics” (Fennema & Sherman, 1976, p. 324).

Therefore, SA and mathematics anxiety are two related but distinct constructs. Overall, mathematics anxiety is cognitive and relates to the manipulation of numbers (Lyons & Beilock, 2012). In contrast, SA is an array of emotional reactions arising from any form of encounter to statistics (Onwuegbuzie, 2004). Baloğlu (2003) acknowledged that SA is likely noncognitive when he reviewed the literature that demonstrated significant differences between learning statistics and learning mathematics based on the cognitive processes involved. From a theoretical perspective, mathematics anxiety refers to a feeling of fear or tension and is a fear of mathematics. It is likely that mathematics anxiety relates to SA and may be rooted in similar underlying causes (Baloğlu, 2003).

While SA may sometimes be confused as a synonym for mathematics anxiety, SA is a situation-specific type of anxiety wherein an individual experiences stress when faced with or exposed to statistics concepts, problems, and contexts (Cruise et al., 1985). To distinguish SA from mathematics anxiety, Cruise et al. (1985) developed a six-component model of SA comprised of “(a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of statistics teachers” (p.

43). From this model, Cruise et al. constructed the Statistics Anxiety Rating Scale (STARS) as a standardized instrument to measure different levels of SA. The STARS is a 51-item questionnaire that measures SA distinctly from mathematics anxiety. This instrument was the first measure that could assess SA as its construct, one separate from mathematics anxiety.

A longitudinal study that Malik (2014) conducted illustrated a sharp distinction between SA and mathematics. The goal of Malik's study was to substantiate that these constructs were different. Therefore, the student investigator used distinct pedagogical models. In the study, Malik used the SSAS and the Students' Mathematics Anxiety Scale (SMAS) to investigate different variables associated with the levels of the two instruments (college students, college year, mathematics background, gender, and the major field of study). The spring 2013 study involved 309 undergraduate students enrolled in an introductory statistics course or a college algebra course. According to the findings, the relationship between anxiety and the gender of students in the statistics introductory course and those in the algebra course revealed demographic differences, primarily concerning the impact of SA and mathematics anxiety on male and female students. Additionally, Malik found significant differences between the levels of SA and mathematics anxiety based on the major field of study. The results of this study revealed that there is a statistically significant difference between STEM and non-STEM majors when experiencing SA .

In contrast, mathematics anxiety did not show a statistically significant difference between STEM and non-STEM majors. Malik's (2014) research concluded that differences in SA exist between STEM and non-STEM majors. Of particular interest are the findings on anxiety and gender, as well as the student's field of study, which revealed significant differences between the impact of SA as compared to the impact of mathematics anxiety (Malik, 2014). These findings are essential to the current POP study because nursing is a non-

STEM major, and the majority of nursing students are female. Therefore, the current study provides information about how SA differs from mathematics anxiety within this context.

Furthermore, Bui and Alfaro (2011) obtained similar results in their research regarding SA's relationship to gender. The researchers used the Test of Science Related Attitudes (TOSRA) and STARS to investigate the relationship between SA and gender among college students. In this study, which examined 104 undergraduates, TOSRA and STARS did not show statistically significant differences in the levels of SA between females and males. In contrast, the researchers found that the prevalence of mathematics anxiety differs significantly between females and males. Therefore, SA may manifest differently from mathematics anxiety across the demographics.

Mathematics anxiety and SA may be intrinsically linked, but they affect students differently in how they manifest. Therefore, when considering the effect of SA, it is essential to consider the student's past experiences with mathematics.

Statistics Anxiety and Student Attitudes

Many studies refer to the high anxiety experienced by students majoring in the social sciences (sociology, education, psychology), who have less interest in mathematics and the hard sciences (Onwuegbuzie, 2004; Onwuegbuzie & Wilson, 2003) or undervalue the difficulty of statistics in these courses (Ruggeri, Diaz et al., 2008). In effect, once these social science students enroll in statistics courses, they experience a series of problems, such as feeling anxious, worry, stress, and apprehension in written examinations or preparation for coursework and other evaluative work (Macher, Paechter, Papousek, Ruggeri, Freudenthaler et al., 2012).

Macher, Paechter, Papousek, Ruggeri, Freudenthaler et al. (2012) studied the relationships between SA, attitudes toward statistics, self-concept, the general disposition to anxiety, and actual experiences of anxiety in the context of an undergraduate psychology program. They sampled 284 psychology students and instructed them to complete the STARS questionnaire, the State-Trait Anxiety Inventory, the Self-Concept in Mathematics tool, and the Interest in Statistics questionnaire. The researchers measured the students' pre-examination scores using the Kurz-Skala Stimmung/Aktivierung scale, a self-reporting depression measure. Twenty-five minutes after beginning the exam, the researchers again measured the students' anxiety levels using the same scale. Moreover, the researchers used structural equation modeling to test existing relationships between and among the variables.

Macher, Paechter, Papousek, and Ruggeri (2012), found that SA was one of the dispositional factors leading to low academic achievement among college students who were in majors that required statistical analysis. Overall, they found that statistics was the most anxiety-provoking aspect of the students' pursuit of a psychology degree. Furthermore, the researchers provided evidence that SA negatively influences academic achievement by inhibiting the decrease of SA during statistics examinations. which harms statistics achievement. This research provides further evidence of the link between SA and other forms of anxiety.

Researchers have established that most students who experience SA are those who are majoring in non-mathematics-related disciplines (Schacht & Stewart, 1992; Zeidner, 1991). From the standpoint of learning and research, high SA weakens academic performance in quantitative-based courses and research methodology courses. In health science degree programs, such as nursing, students demonstrate statistics competence. However, researchers have documented that SA debilitates students' ability to obtain skills needed to analytically critique research and interpret research findings, as well as critical skills in proposing, designing, and implementing research studies (Macher, Paechter, Papousek, Ruggeri, Freudenthaler et al., 2012; Onwuegbuzie, 1998). Furthermore, SA affects nontraditional learners more than traditional learners because adults face additional burdens, such as family responsibilities, work, and a longer interval since they last took mathematics-related courses, which could increase their anxiety levels (Imagine America, 2017).

Another study using similar methodology at the University of Graz, Austria, confirmed Macher, Paechter, Papousek, and Ruggeri's (2012) results. Papousek et al.'s (2012) study involved 284 undergraduate students whose ages ranged from 18 to 46 years old. Overall, the results of this study indicated that SA negatively relates to interest in statistics. Together, these studies provide evidence of the relationship between anxiety and academic performance in statistics courses.

Health science courses are associated with the highest levels of SA. As with nursing students, the poor performance of psychology students in statistics subjects is partly the result of a negative attitude (Onwuegbuzie, 2004). When choosing psychology as a major, 45% of participants in Ruggeri, Dempster et al.'s (2011) study were not aware that statistics was part of their curriculum. Using a large sample of 543 students, Ruggeri, Dempster et al. used a questionnaire to collect data about the students' conception of statistics. They found that the majority of students did not recognize or value the need for statistics in their majors. Additionally, the results indicated that most of the participants did not see the benefits of statistics in their careers (Ruggeri, Diaz et al., 2008). Therefore, the students expressed feelings of stress and anxiety when they realized that almost 25% of their psychology degree focused on statistical analysis and research methods. As a result, many students reported that statistics was the most challenging course for them in the psychology degree program and that they did not understand the need for statistics in their future careers. Accordingly, nurses may struggle to see the value of statistics similar to the psychology students in this study.

Researchers have also found that SA increases feelings of uncertainty and worry among college students in general. A. S. Williams (2013) found a relationship between intolerance of uncertainty, worry, and SA in a study involving 97 graduate students from various fields of study. Using a pre-test/post-test methodology of students in a psychology class specifically, A. S. Williams found that SA had a direct relationship with a general sense of worry among the participants in statistics and research programs. This outcome is in alignment with the results from the study Ruggeri, Diaz et al. (2008) conducted using psychology students. This research is significant because it provides evidence that statistics affect student attitudes.

According to Onwuegbuzie (2004), SA is pervasive in many fields of study wherein students identify statistics courses as the most anxiety-inducing courses in their school curriculum. He surveyed 135 graduate students from multiple disciplines using the Procrastination Assessment Scale-Students. His results provided evidence that up to 80% of graduate students experience varying levels of SA. This rate is particularly high considering the increasing number of undergraduate students in the U.S. who are required to take at least one statistics course as a prerequisite in their degree programs (Onwuegbuzie & Wilson, 2003; Onwuegbuzie, 2004). Therefore, it is critical to investigate how SA affects students' academic performance.

Students' attitudes toward statistics may interact with SA to negatively affect achievement and learning outcomes. Hamid and Sulaiman (2014) studied the correlates of SA among 139 psychology students in a Malaysian university. First, they conducted measurements of SA at the start of the course. Then, they measured performance using a mathematics quiz, continuous assessment mark, final examination grade, and total grade. The study found that there was no significant relationship between attitudes about statistics and SA. However, scores on the mathematics quiz significantly predicted the overall statistics course grade. This research provides further evidence that these constructs are not distinctly different, as one could influence the other. Therefore, Hamid and Sulaiman recommended that educators use a pre-test that measures mathematical ability in a statistics course to gauge and improve learning outcomes among students.

Students in social work degree programs have anxiety levels similar to those observed in psychology and nursing students. In a study by Elliot et al. (2013), they identified a high level of student reluctance and avoidance behaviors toward statistics. These behaviors, coupled with a lack of enthusiasm from instructors about teaching statistics, led to high levels of anxiety. For the Masters of Social Work (MSW) students, their learning comprised a mixture of traditional learning methods and online statistics laboratory practice. The results of this study indicated that the 25 MSW students increased their confidence in performing statistics related tasks as they continued doing their course work.

Moreover, Elliot et al. (2013) indicated that the students' confidence increased in areas such as forming hypotheses, forming research questions, and performing electronic literature inquiries. This research showed that students in non-mathematics majors may experience manifestations of SA, which are different from those experienced by students in traditional math-based programs. Social work, like nursing, focuses on the health science application of evidence-based practice principles; thus, students may approach statistics with the same avoidance behaviors and anxieties. Therefore, it may be worth examining nursing students for similarities in social work and psychology students.

As demonstrated, research indicates that students' attitudes regarding the statistics may have a connection to SA. Furthermore, it may relate to the value students attribute to the subject and how it integrates into the required curriculum components. Attitude and anxiety may also relate to students' prior experiences with mathematics-related subjects.

Statistics Anxiety and Avoidance Behaviors

In addition to the factors that affect mathematics anxiety in students, other factors directly tie to SA. While investigating these other factors, Erden and Agkul (2010) observed that preconceived ideas concerning the alleged difficulties in statistics-related courses influence the numbers of enrolled students. These researchers also noted that a majority of students rated statistics topics as the least popular subject as compared to other subjects. The sample from this study consisted of 292 seventh and eighth-grade students in Istanbul. The correlational results indicated that mathematics anxiety was a significant predictor of mathematics achievement.

Interestingly, mathematics anxiety was a more powerful predictor of mathematics achievement for males than females, while mathematics anxiety in females more highly correlates with educator behavior. This fact aligns with the conclusions Bui and Alfaro (2009) drew when they identified statistically significant differences in the levels of SA between females and males. Together, these results indicate that students may have better mathematical success when they experience less anxiety about mathematics. In their study, Erden and Agkul (2010) found that most individuals tend to evade or postpone taking mathematics-based courses until the end of their degree program, fearing that poor performance in these classes may influence their performance in other courses. In congruence with those results, Onwuegbuzie (2000) also noted that academic anxiety may be particularly rampant in students who lack adequate self-efficacy. These studies provide insight into how anxiety about statistics affects academic achievement.

Along with increased anxiety and a lack of self-efficacy, other fears may also relate to student performance. Using a sample of 400 high school students in Tehran, Kiamanesh et al. (2004) assessed students on math anxiety, math self-concept, perceived usefulness of math, math self-efficacy, and math achievement. They noted that many students evade mathematics-related subjects, such as statistics, due to the fear that these courses are particularly hard. Also, these researchers found that most students often feel that such courses will affect their GPA negatively, which prevents them from taking the course. Research indicates that college-level statistics courses are some of the most challenging classes that undergraduate and graduate students face (Kiamanesh et al., 2004). Therefore, SA may relate to avoidance behaviors and concerns about overall academic achievement.

While investigating the effect of academic performance on avoidance behaviors, Yan and Horwitz (2008) listed some of the consequences of anxiety in academic subjects—including poor performance, low levels of conceptual understanding of the concepts, high numbers of dropouts, and avoidance of the subject–among others. The researchers conducted semi-structured interviews with 21 students in China who had various levels of general academic-related anxiety. The primary goal of the study was to learn about academic anxiety in foreign language acquisition, but the researchers also asked questions about academic anxiety in other subjects as well.

As a result, Yan and Horwitz (2008) found that in statistics classes, anxiety levels influenced the performance of the individuals directly, in that they suffered from anxiety and did more poorly than those performing under normal conditions. For instance, if under normal circumstances a student could analyze a statistics problem within a few minutes, higher levels of anxiety would slow down the student's reasoning skills, thereby reducing that student's ability to perform. Therefore, SA may result in issues that relate to academic performance as students with high levels of SA are likely to underperform.

Apart from the associated analytical and reasoning skill challenges that many students encounter, research indicates that psychological factors form part of the challenges affecting the ability of the student to learn. In a study conducted to investigate how psychological factors relate to SA, Prevatt et al. (2010) analyzed a sample of 115 undergraduate students. They found that over 50% of the participants perceived statistics subjects as the most feared, least enjoyable, most stressful, and least understood courses within their learning. These researchers also found that anxiety was a moderator of the relationship between memory and mathematics achievement, and anxiety directly affected mathematics performance. This study provides further evidence that when students do not recognize the value of the subject, it may manifest into anxiety, resulting in avoidance behaviors.

According to Zeidner (1991), SA relates to statistics test anxiety, statistics, content anxiety, and the student's history of success and failure in mathematics. The SA experienced by the student, as a result, may lead them to avoid taking classes involving statistics. The sample in the Zeidner study included 431 students in the behavioral sciences department of the University of Haifa in Israel. Each student in the study had taken and passed an undergraduate statistics course. The researchers used the Statistics Anxiety Inventory, which contains 40 questions focused on anxiety about statistics content, statistics performance, and problem-solving capacity.

Zeidner's (1991) results indicated that students' perceived college-level statistics as a moderately anxiety-evoking subject. Forty-eight percent of the students sampled perceived statistics as more difficult than any other college course. The results also provided evidence of the potential correlation between SA and statistics course performance. The author suggested that mathematical ability may be a main factor contributing to SA and academic performance. Zeidner concluded that negative prior mathematics experiences, poor mathematics achievement, and a profound sense of mathematics self-efficacy significantly correlate to statistics test anxiety. Therefore, self-esteem and self-efficacy may be significant antecedents to SA.

While SA may relate to self-efficacy and course performance indicators, there is also evidence that student attitudes, behaviors, and beliefs may mediate these relationships. Therefore, it is essential to consider the effect of student attitudes on SA levels, especially in students enrolled in non-mathematics-based majors.

Cognitive Effects of Anxiety

Academic achievement may correlate with cognitive ability and student anxiety levels. Ferla et al. (2009) tested the hypothesis that students who performed highly on academic achievement measures would have lower levels of anxiety compared to other students. The data in this study came from Belgian data obtained as part of the 2003 PISA-survey. The sample is representative of the 15 year-old Belgian high school student population, which comprises 8,796 students from 277 schools. Variables from the PISA instrument included students' mathematics self-efficacy, mathematics self-concept, mathematics anxiety, and mathematics interest. Additional variables, including gender, prior mathematics grade, the difficulty level of the high school curriculum, and mathematics score, were included in the analysis. The researchers took the students through a cognitive ability test that measured their anxiety levels. The tests indicated that students who had performed poorly had higher levels of anxiety compared to the other students. This outcome provides evidence of the inverse relationship between anxiety and achievement.

Ma's (1999) research suggested that an academic challenge often triggers anxiety. His meta-analysis examined 26 studies to investigate the relationship between anxiety and achievement in mathematics. The results indicated that the consequences of being anxious toward mathematics subjects commonly include the inability to do mathematics, a decline in mathematics achievement, avoidance of mathematics courses, and limitations in choosing college majors and future careers. Additionally, gender, age, and race/ethnicity contribute to the effects of mathematics anxiety and achievement and may serve as mediating variables. As such, the different challenges and analytical issues involved in mathematics may add to anxiety in students, causing their levels of anxiety and stress to increase when exposed to tests and challenges.

In another study exploring the relationship between anxiety and cognition, Jansen et al. (2013) investigated how anxiety affects students with behavior disorders and learning disabilities. These researchers assessed the relationship between self-concept, internal dialogue, and the achievements of the students taking the Scholastic Assessment Test (SAT). In their study, Jansen et al. compared the results of 207 children who took two standardized SATs. The researchers found that there was a consistent moderate improvement in the students' results for the second test. This outcome indicates that there is a relationship between internal dialogue and mathematical anxiety among the students. The study findings also demonstrated that performance on academic indicators increases as anxiety levels decrease. The researchers saw the same results concerning self-concept. This outcome indicates that for some students, anxiety levels elevate when their instructor exposes them to tests, suggesting that mathematics anxiety directly affects the performance of students.

A study conducted by Ashcraft and Kirk (2001) investigated how mathematics anxiety correlates with working memory and performance. They measured working memory using a computation-span task. The researchers measured reaction time and the number of errors a participant made when performing mental addition concurrently with a memory load task. The participants consisted of 66 students from undergraduate psychology classes. The study found that people with mathematics anxiety have a smaller working span, mainly when the task at hand is computation-based. The decreased working memory translated into a significant increase in errors and reaction time, especially when a mental calculation was completed simultaneously with a memory load task. This outcome provided evidence that people with high mathematics anxiety, score lower grades in mathematics classes and that working memory anxiety negatively relates to mathematics anxiety. Ashcraft (2002) also found that people with high mathematics anxiety, struggle with addition problems that have a carry operation. These results provide evidence of the cognitive effects of mathematics anxiety on psychology students, suggesting that cognition and anxiety are linked.

In research conducted by Legg and Locker (2009), they saw a connection between metacognition to mathematics anxiety. The researchers studied 56 undergraduate students enrolled in an introductory psychology course at Georgia Southern University. They used the Revised Math Anxiety Rating Scale to assess the levels of mathematics anxiety the students experienced. In this case, performance on mathematics tasks decreased as anxiety increased, except at high cognition levels. When anxiety was high, students showed deficient performance levels. However, metacognition was useful in predicting a student's confidence in their accuracy. This research illustrates that students with higher metacognitive processing skills are more confident in their abilities to answer problems correctly. The researchers also found that participants with low anxiety levels could use metacognition positively. This outcome provides additional evidence of a connection between metacognition, anxiety, and achievement.

Additionally, Lyons and Beilock's (2012) observed the relationship between mathematics anxiety and cognition using neural imaging. Their study used functional magnetic resonance imaging (fMRI) and found that some students with high levels of anxiety could use cognitive control resources to manage the anxiety so that it did not interfere with their mathematics processing. They studied a sample of 32 students from the University of Chicago between the ages of 18 and 25. The researchers separated the students into high anxiety and low anxiety groups using the math anxiety rating scale (MARS) instrument. The participants conducted mathematics and word tasks in a blocked design while recorded by fMRI technology. The results from the study indicated that there was increased activity in the frontoparietal region of the brain for participants with high mathematics anxiety. This increased activity still occurred when the participants were merely anticipating the activity of doing mathematics. When the participants were doing activities involving mathematical operations, there was activity in the caudate, nucleus accumbens, and hippocampus areas of the brain in high mathematically-anxious individuals. Lyons and Beilock's research suggests that the cognitive disturbances observed in individuals with high levels of mathematics anxiety may be due to biological differences in brain structure and function.

Cognitive effects on memory and learning may influence anxiety levels in mathematics and statistics students. These results are applicable in the nursing practice, especially considering the working memory intensiveness of most of the tasks in the profession.

Effect of Mathematics Anxiety in Clinical Nursing

The population of interest in this POP study was nursing students; therefore, it was essential to consider how academic anxiety impacts nurses' ability in clinical applications. Nursing students must have unique mathematics skills and abilities due to the clinical practice of calculating medication dosages (Fulton & O'Neill, 1989; M. B. Hodge, 1999; J. E. Hodge, 2002; K. A. Walsh, 2008; Wright, 2007). The previous section described how mathematics and SA could affect cognitive capacity in students. However, for nurses, it extends into their clinical abilities since part of the nursing curriculum requires students to take classes and work in the hospital with patients simultaneously. Therefore, mathematics-based anxiety could manifest in problems calculating medication dosages. While the effect of mathematics anxiety on these clinical skills has remained a prevalent topic, the explanations researchers have provided for the disparity have shifted over the years (Wright, 2007).

An experimental study conducted by Fulton and O'Neill (1989) investigated the effects of different teaching methods on mathematics anxiety and students' ability to accurately calculate drug dosages. The sample consisted of 80 students the researchers had randomly chosen from 160 first-year nursing students in a community college nursing program in Ontario, Canada. The researchers stated that social factors are the primary cause of mathematics avoidance and that society has accepted students' weaknesses in mathematics through the 1980s. Additionally, the researchers suggested that women may have chosen nursing careers, in part, because they feared number manipulation, did not expect the nursing program to have mathematics as part of the curriculum, and those with high anxiety did not voluntarily enroll in mathematics classes. The researchers stated that nursing students were 90% female and had specific social and cultural factors that may have impaired their ability to compute mathematical concepts.

Fulton and O'Neill (1989) randomly assigned students in their study to either the treatment or control group, where they tested them on their ability to calculate accurately fractional drug dosages. The intervention in this study used pedagogical changes focusing on verbalizing feelings to explore how it could help students reduce mathematics anxiety and increase their ability to calculate drug dosages accurately. The student investigator identified statistically significant differences between the pre-test/post-test mathematics anxiety scores or arithmetic test scores.

As a result, Fulton and O'Neill (1989) concluded that changing the teaching style to focus on verbalizing feelings did not affect levels of mathematics anxiety or arithmetic ability. They hypothesized that this generation of students was not as mathematically anxious as were previous generations. The researchers conducted this study before the 1990s, when changes in attitudes concerning gender roles began to emerge. Previously, mathematics was a male-dominated subject. Therefore, it is essential to recognize that as social conditions change, research about the relationships between mathematics anxiety and mathematics variables will continue to evolve. The results that Fulton and O'Neill identified may not be generalizable to the students taking classes in the 2020s; however, the themes that emerged that relate to pedagogy may still be relevant.

Building on the results of Fulton and O'Neill (1989), a quantitative study conducted by M. B. Hodge (1999) sought to identify factors affecting competency in mathematics by studying undergraduate nursing students. M. B. Hodge assumed that the majority of nursing students were women and that gender-associated factors could affect mathematics achievement. The results of the study were consistent with those that Fulton and O'Neill found one decade earlier. The outcome of the study indicated that test anxiety, mathematics self-efficacy, and previous achievement in mathematics classes affected the students' performance on drug dosage calculation examinations. However, the students' gender did not affect either mathematics anxiety or the drug dosage calculation score. M. B. Hodge attributed the cognitive differences in the students' problem-solving skills, learning styles, and mathematical self-concepts to neuroeducational factors that relate to effectively making drug dosage calculations. This outcome is consistent with the cognitive effects studied by Lyons and Beilock (2012).

M. B. Hodge (1999) also noted that personal attributes, such as self-concept and self-efficacy, are known to play a role in the mathematical achievement of women, as supported by research identifying the relationship between SA and self-concept (Baloğlu, 2003). Therefore, the author of this current study suggests that, when other researchers study the mathematics achievement and anxiety levels of students in female-dominated professions, such as nursing, instead of focusing on gender, they should explore factors, such as self-concept and self-efficacy.

An additional study conducted by J. E. Hodge (2002) investigated the effect of mathematics anxiety and mathematics self-efficacy on drug dosage calculations. The sample consisted of 40 undergraduate nursing students enrolled in a math course for nurses at a small, private university in West Virginia. Instruments used included the Mental Agility Series (MAS), Mathematics Self-Efficacy Scale (MSES), and a drug dosage calculation exam. The results indicated that mathematics anxiety was a factor in the ability of nursing students to calculate drug dosages, but it was not significant. Mathematics self-efficacy did, however, show a statistically significant relationship with undergraduate nursing students' abilities to calculate drug dosages. This outcome highlights the complicated relationship that exists between student anxiety and self-efficacy levels and how they could impact student performance in clinical practice.

Another study assessing the relationship between mathematics anxiety, self-efficacy, and drug dosage calculations was K. A. Walsh's (2008) mixed-methods research conducted on 108 third-semester associate degree nursing students in a nursing program in the suburban Northeast United States. The student investigator used a 50-item survey to collect data for the study using a mathematics beliefs, anxiety, and self-efficacy assessment questionnaire with a five-point Likert-type scale, which included questions that related to mathematics anxiety, beliefs about mathematical questions, demographic data, and SAT scores. The final question on the instrument was an open-ended question where she asked students to reflect upon their experiences, thoughts, and feelings about mathematics anxiety and self-efficacy. After that, the students took a ten-question nursing mathematics test that included typical clinical setting, drug dosage calculations. In this study, higher levels of mathematics anxiety negatively correlated with the students' beliefs about mathematics, but there was no statistically significant relationship observed between mathematics anxiety, mathematics self-efficacy, or performance on the medication mathematics test. The quantitative results of this study demonstrated that participants were not overly anxious about mathematics, as the average anxiety level was "slightly anxious." However, the qualitative results indicated that students individually felt mathematics test anxiety as opposed to general mathematics anxiety.

As Zeidner (1991) noted, students with negative prior mathematics experiences, poor mathematics achievement, and a deep sense of mathematics self-efficacy, have higher levels of SA. Therefore, the evidence of mathematics anxiety in nursing students may impact the levels of SA in the same population. While the study by K. A. Walsh (2008) did not find that students were especially anxious about mathematics, the participants expressed that they understood the importance of mathematics in their lives and their work. Therefore, they did not express high levels of anxiety because they realized that the skills involved in dosage calculations could have severe clinical repercussions outside of merely answering questions on a test. These results align with those discovered by J. E. Hodge (2002) and confirm the relationship between mathematics anxiety and clinical ability regarding drug dosage calculations. Thus, improving students' perceptions of the importance of mathematics skills could effectively decrease student anxiety levels and improve nursing abilities.

The relationship between mathematics anxiety and dosage calculations has evolved over the past 30 years (Wright, 2007). Initially, researchers considered gender a prominent factor linking mathematics anxiety to incorrectly calculating drug dosages. However, self-efficacy may also be an essential consideration (Fulton & O'Neill, 1989). Additionally, while mathematics anxiety may be prevalent in nursing students, these students may feel even greater anxiety toward specific forms of assessment, such as taking exams (M. B. Hodge, 1999). Because mathematics skills intrinsically connect to clinical skills—such as calculating drug dosages—students may experience lower levels of academic anxiety when they recognize the clinical relevance of these skills (J. E. Hodge, 2002; K. A. Walsh, 2008).

Furthermore, as society changes, students and educators change in tandem. Therefore, what researchers know about the relationship between mathematics anxiety and mathematics ability will evolve. What neuroeducation once assumed factual may no longer be accurate as time progresses; therefore, it is necessary to identify the effects that changing sociological constructs may have on this population of nursing students.

Instructor Effect on Anxiety

Attitudes about mathematics, statistics, learning, and teaching may affect student learning outcomes. Beilock et al.'s (2010) study found that female mathematically-anxious educators transmitted mathematics anxiety to their female elementary students. The researchers measured the mathematics anxiety levels of 17 first and second-grade teachers in a large, Midwestern, urban school district. They then assessed the mathematics achievement levels of the educators' 117 students. They found that at the beginning of the school year, there was no relationship between teacher anxiety and student success, but by the end of the school year, the higher the mathematics anxiety of the educator, the lower the mathematics achievement of the girls. However, teachers' anxiety did not affect the boys.

Furthermore, there was not a relationship between educator mathematics anxiety and students' gender beliefs at the beginning of the school year. However, by the end of the year, the higher the teachers' levels of mathematics anxiety, the more likely the girls were to believe in traditional gender stereotypes concerning mathematics ability. The boys did not change from the beginning of the school year to the end. This research provides evidence that educator anxiety could negatively affect female students' mathematics achievements and gender-ability beliefs. Therefore, if an educator has high levels of mathematics anxiety, girls may begin to believe the stereotype that they are not as good at mathematics as boys. If these types of interactions begin as early as first or second grade, they can potentially set the foundation for a lifetime of mathematics anxiety, which could be particularly detrimental to older students.

In a follow-up article, Beilock and Willingham (2014) recruited 70 educators and their 650 students. The results of their study indicated that teachers' mathematics anxiety negatively affected the boys' mathematics achievement indicators. Given this additional evidence, it appears that the anxiety level of the educator affects male and female student anxiety levels. Thus, an educator's mathematics anxiety could also affect students' mathematics achievements.

Based on existing research, one could see that the attitudes of an instructor could also impact the attitudes of the students. Statistics is a branch of mathematics; consequently, the anxiety students experience in general mathematics courses is similar to what Zeidner (1991) observed in statistics courses. Attrition in college statistics courses is attributable to low self-efficacy, high anxiety, and course avoidance (Fulton & O'Neill, 1998; Ma, 1999; Yan & Horwitz, 2008). As a result, the attitude of the instructor may impact the anxiety levels and attrition rates of the students.

Statistics Anxiety and Nursing Students

The author of this literature review found several studies on mathematics anxiety, and one, by Welch et al. (2015), which relates to SA that included dental hygiene students. However, the student investigator could not locate any articles that relate to students pursuing a nursing degree. The study on SA among dental hygiene students assessed SA using the STARS and found that these students experienced low to moderate levels of SA, primarily that relate to interpretation anxiety and making sense of scientific research. However, 92% of the participants indicated that statistics is essential for evidence-based practice and responded that it should be a required course for dental hygiene students. These results may be generalizable to other health professions, such as nursing. The current study was, therefore, warranted given the paucity of research on SA among nursing students. Nurses must comprehend statistical measures and concepts to critically examine and comprehend research articles and apply the evidence to their practice.

Mathematics Anxiety and Nursing Students

An exhaustive search of electronic databases did not yield recent research that explores the levels of SA with American nursing students. However, extensive research has shown that mathematics anxiety is a significant issue for most students—including nursing students. This anxiety also affects nursing student performance, especially in mathematics-related courses. Pourmoslemi et al. (2013) studied 275 undergraduate students who were taking general mathematics courses at the Payame University of Hamedan, Iran, to investigate the level of mathematics anxiety and its influence on mathematics performance among undergraduate students. The student ages ranged between 18 and 30, with a mean age of 20.65. An advantage of the research model utilized was that the researchers employed random sampling; hence, chances of sampling bias were minimal. The study also utilized a 98-item MARS, which is known for its high reliability and validity. The results indicate that high mathematics anxiety is widespread among students, especially when they are in the exam room. This outcome is consistent with K. A. Walsh's (2008) research, where the results indicated that nursing students experience high levels of mathematics anxiety.

Moreover, the study provides evidence that the difference in anxiety levels among students in different fields is insignificant. Consequently, the levels of anxiety exhibited by nursing students are comparable to those exhibited by students in other fields, such as engineering students. The most notable result Pourmoslemi et al.'s (2013) study was the negative correlation between high mathematics anxiety and decreased mathematical achievement, as additional anxiety translated to lower grades. This outcome is consistent with results indicating that higher anxiety corresponds with lower grades in nursing students (Andrew et al., 2009; McMullan et al., 2012; Røykenes & Larsen, 2010).

A study by Bull (2009) identified a 45% prevalence of mathematics anxiety among student nurses. The participants included 63 nursing students between 18 and 50 years of age in a diploma program at a university in the U.K. Bull hypothesized that nursing students have higher mathematics anxiety and that this anxiety has a close relationship to poor mathematics performance. Therefore, Bull evaluated students' anxiety levels about their reliance on calculators, as well as their comprehension of the multiplication table. This test aimed to show the association between anxiety and manual skills among the participants. Accordingly, the student investigator gave the participants two questionnaires and a diagnostics mathematics test intended to evaluate the level of anxiety among the students. They also collected information on students' mathematics backgrounds.

Bull (2009) asked the students to demonstrate their comprehension of the mathematical table and evaluated students' reliance on calculators. Then, the student investigator gave the participants a 20-item diagnostic mathematics test. The pre-test/post-test analysis demonstrated that there was a positive correlation between mathematics anxiety and self-efficacy among the nursing students. This outcome is consistent with the results K. A. Walsh (2008) and J. E. Hodge (2002) obtained, when they discovered a relationship between mathematics anxiety and self-efficacy in nursing students. Consequently, high levels of mathematics anxiety could lead to poor performance on mathematical calculations, ultimately affecting overall achievement levels.

Research conducted by Glaister (2007) explored how computer and mathematics anxiety affect the learning of dosage calculations among students. A quasi-experimental randomized design was employed to study 97 second-year nursing students from Australia who were using integrative and computer-based approaches to learning statistics. Each student could participate in only one of the three available instructional approaches: computerized learning, integrative learning, or computerized and integrative learning. Glaister used a pre-test/post-test quasi-experimental design. The results of the study indicated the prevalence of mathematics anxiety among the student nurses, consistent with the observations made by Bull (2009) and Pourmoslemi et al. (2013). Students with a negative attitude regarding mathematics performed poorly compared to their counterparts who had a positive attitude toward mathematics. Furthermore, individuals with higher anxiety and negative thoughts about mathematics testing, specifically, were more likely to perform poorly compared to their counterparts who were more comfortable with mathematics testing. Furthermore, the results of this study indicated that nursing students with a poor attitude concerning statistics, experience higher levels of SA, and more unsatisfactory performance in the course.

Mathematics anxiety may affect academic performance in a variety of ways. Research by Beall et al. (2015) further investigated the relationship between mathematics anxiety, mathematics performance, and mathematics education in undergraduate student nurses. The study compared the three variables with sophomore and senior nursing students. This particular study was descriptive and cross-sectional. Furthermore, Beall et al. referenced Bandura's (1977) self-efficacy theory throughout the study. The participants, selected through convenience sampling, were 164 nursing undergraduate students over 18 years of age at a university in the Midwest. After gathering their demographic information, the researchers gave the participants a short test to analyze their mathematical ability. Then, they collected the participants' perceptions of learning, solving, thinking about, and talking about mathematics.

The study found no relationship between mathematics performance and mathematics education, but it provided evidence that self-perception is an essential component of performing well on drug calculations and mathematics tests. Due to the substantial effects of mathematics anxiety, Beall et al. (2015) suggested that mathematics content be delivered earlier within nursing programs. These results indicated there may be a relationship between SA and SSE that connects students' ability to perform well on drug calculations and quantitative assessments. These results are consistent with outcomes from previous studies demonstrating that mathematics anxiety may impact clinical nursing practice, especially the act of calculating drug dosages (Fulton & O'Neill, 1989; M. B. Hodge, 1999; J. E. Hodge, 2002; K. A. Walsh, 2008).

A cross-sectional study conducted by McMullan et al. (2012) explored how mathematics anxiety, self-efficacy, and numerical ability influence the ability to perform drug calculations. Like the study conducted by Beall et al. (2015), this study explored how anxiety and self-efficacy impacted clinical ability. The study included 229 second-year undergraduate student nurses at a university in the U.K. Measurements entailed a MAS, a numerical ability test, a MSES, and a drug calculation ability test. The results indicated that anxiety relates to drug calculation inability. The study also sought to identify which of the three factors affected calculation skills the most. The researchers discovered significant relationships between anxiety, self-efficacy, and ability. Those who failed in either drug calculation or numerical tests, or both, had higher levels of anxiety and lower confidence in their ability to perform calculations as compared to those who passed.

These results align with research indicating that mathematics anxiety may impair calculating drug dosage ability (Beall et al., 2015; Fulton & O'Neill, 1989; M. B. Hodge, 1999; J. E. Hodge, 2002; K. A. Walsh, 2008). Numerical ability and self-efficacy had more influence on the ability to perform drug calculations than mathematics anxiety; however, that does not imply that anxiety has no influence. Therefore, mathematics anxiety may relate to SA, as they potentially impact nursing students' ability to calculate drug dosages accurately.

Another study, like those that Beall et al. (2015) and McMullan et al. (2012) conducted was by Andrew et al. (2009), which explored how confidence influences the performance of student nurses in mathematics exams, as well as in their ability to make medication calculations. Andrew et al.'s research included 123 second-year students at a university in New South Wales, Australia, where they examined the students' self-efficacy in mathematics using the National Standard Examination–Math, a scale comprised of items that associate with arithmetic and mathematic concepts. The instrument measures the self-efficacy and mathematics skills of students who use arithmetic and mathematics concepts that relate directly to drug dosage calculations. The results demonstrated that participants with low self-efficacy received low marks on their mathematics exams. These results provide further evidence of the link between mathematics confidence, exam scores, and drug calculation abilities.

While previous research focused on the relationship between self-efficacy, clinical ability, and academic grades, Røykenes and Larsen (2010) explored the association between the performance of nursing students on drug calculation tests and the students' mathematics ability. The participants were 116 nursing students at a university college in Norway, between the ages of 19 and 46. The quantitative study included test results and a questionnaire. The study investigated how a student's mathematics experience in school related to the student's beliefs about their ability to master the drug calculation test. The participants who perceived their mathematical acumen as wanting had greater difficulty obtaining no errors on the test.

These results indicated that low confidence could lead to anxiety, which in turn could lead to failure of the drug calculation test, consistent with those results discovered in prior studies (Andrew et al., 2009; Beall et al., 2015; Fulton & O'Neill, 1989; M. B. Hodge, 1999; J. E. Hodge, 2002; K. A. Walsh, 2008). In general, this shows a relationship between test failure and low grades. Additionally, there is a relationship between a person's assessment of their mathematical skills and their capacity for proficiency on the drug calculation test. The results of this study indicate that a person with low confidence could have high levels of anxiety, and hence, they could be more likely to fail the test.

In addition to student performance, Melius (2012) conducted a study to explore how mathematics anxiety among nurses influenced their performance in the workplace. The participants were 89 licensed nurses, including licensed vocational nurses (LVNs) and registered nurses stationed in an acute care facility in Texas. The study used a quantitative correlational design wherein participants filled out a nurse self-efficacy for mathematics scale, a MAS, and completed a medication calculation test. The study analyzed the relationship between nurses' self-efficacy for mathematics and mathematics anxiety and the performance of acute care nurses performing medical calculations. Findings from this sample population demonstrated that the nurses were somewhat weak in their mathematics skills.

Furthermore, the number of hours worked, coupled with mathematics anxiety, were also chief factors contributing to mathematical errors among the participants. The nurses in Melius's (2012) study had a level of mathematics anxiety, as shown by their scores on the MAS, that influenced their ability to perform dosage calculations. This finding supports the idea that mathematics anxiety and dosage calculation ability may be linked, which is in alignment with earlier research (Andrew et al., 2009; Beall et al., 2015; Fulton & O'Neill, 1989; M. B. Hodge, 1999; J. E. Hodge, 2002; K. A. Walsh, 2008).

Further examining the issue of anxiety, Choudhary and Malthus (2017) conducted a study to evaluate the viability of learning development in helping student nurses overcome anxiety and develop the confidence to tackle drug calculations successfully. The participants in the study were 27 first-year students taking a bachelor of nursing course at the New Zealand Institute of Technology. The participants had each attended at least five voluntary mathematics tutorials. The researchers found that learning development improved after instructors used voluntary supplementary mathematics tutorial sessions on mathematics anxiety, numeracy skills, and necessary drug calculations. Therefore, results indicated that attending the tutorials had a positive influence on numeracy skills. Consequently, enhanced numeracy skills translated to lower levels of anxiety, and in turn, better performance. This research provides further evidence of the link between mathematics anxiety and drug calculation ability in nursing students.

The studies presented in this chapter have shown that self-efficacy and mathematics anxiety are closely related (Andrew et al., 2009; Beall et al., 2015; McMullan et al., 2012). Additionally, the previously stated results indicated that student nurses with high levels of anxiety are apt to fail drug calculation tests and struggle with applying numeracy skills in clinical settings (Fulton & O'Neill, 1989; M. B. Hodge, 1999; J. E. Hodge, 2002; K. A. Walsh, 2008). Therefore, anxiety, self-efficacy, and clinical ability may each have a link to mathematics anxiety in nursing education.

Statistics Anxiety and Adult Students

Studies have explored the antecedents of SA among students; however, there may be differences in nontraditional students, such as those who are adult learners. A study conducted by Bui and Alfaro (2009) assessed the anxiety levels of 104 undergraduate students enrolled in an introductory statistics class at a university in Southern California. Nontraditional students (those who are 25 years old and older) reported higher SA in written examinations in statistics classes compared to traditional students. Moreover, the results indicated that the students of all genders, ethnicities, and age groups reported high levels of anxiety that related to the interpretation of statistics, as well as taking tests in a statistics class.

Additionally, older students reported having high levels of SA and lower levels of SSE. The longer it had been since a student had taken a mathematics class, the more anxiety the student experienced related to statistics. Therefore, adult students had higher levels of anxiety and a lower levels of self-efficacy as a result of not having taken a mathematics class as recently as traditionally aged students.

In a study by Bill (2003), he compared the statistics course outcomes and performances among traditional and nontraditional students. The sample comprised 121 introductory business students. The results of the study indicated that the only way in which the adult students differed from the traditional students was that the adult students had statistically significant higher levels of statistics test and statistics class anxiety. The traditional students garnered significantly higher final grades in the statistics course compared to nontraditional students. Bill suggested that the weaker performance demonstrated by nontraditional students was due in part to their SA, as well as the long interval since they had last taken mathematics courses before enrolling in the present statistics course. This outcome is consistent with the results obtained by Bui and Alfaro (2009), who found that adult students who had not taken mathematics classes recently had higher levels of SA than their traditional-aged counterparts. These studies together provide evidence of the effect of SA on adult students and indicate that anxiety levels may differ between traditional and nontraditional adult students.

Baloğlu (2003) conducted a study of 246 college students investigating the differences in SA levels based on students' gender and age using a multivariate analysis of covariance. He measured anxiety using the STARS with the six dependent variables from subscales within the STARS instrument. These subscales were (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of statistics instructors. The independent variables were gender and age, while previous math experience was a covariate. In this study, the student investigator divided the participants into three categories: younger than 21 years of age, between 22 and 26 years of age, and 27 or older. The student investigator did not identify any statistically significant gender effects; however, there were statistically significant effects of age and previous math experience. The results indicated that there was a statistically significant main effect of age. In particular, older students had higher statistics test and statistics class anxiety when compared to younger students. Though, older students reported positive attitudes toward the usefulness of statistics (Baloğlu, 2003). This outcome indicates that interventions aimed at decreasing student anxiety may differ for older and younger students.

While the studies of traditional and nontraditional students yielded significant findings crucial for instructors to devise methods for lessening SA, they did not investigate how SA is associated with other student characteristics. Therefore, the student investigator conducting this POP study compared the SA of traditional and nontraditional adult undergraduate nursing students to fill this research gap.

Self-Efficacy and Statistics Anxiety

Self-efficacy is an essential concept that researchers tend to study in tandem with anxiety. Additionally, researchers have conducted studies of SSE and SA with nontraditional adult learners in non-mathematics disciplines, but not in a context-specific to nursing. While no particular study focusing on SA in the context of a nursing student population exists, there is a wealth of research on the impact of SSE and SA among different non-mathematics-oriented disciplines, involving nontraditional adult learners.

In a correlational study by Perepiczka et al. (2011), they explored the relationships of 166 master's and doctoral students' SSE, SA, social support, and attitudes about statistics. The researchers used standardized measures to operationalize the variables. As a result, they uncovered various negative and positive correlations among the variables. Consistent with previous findings, other researchers have found a statistically significant negative relationship between SSE and SA (Andrew et al., 2009; Beall et al., 2015; McMullan et al., 2012). They established similar negative relationships between SSE and social support, as well as between SSE and attitudes toward statistics.

Furthermore, Perepiczka et al. (2011) used the STARS scale to measure SA. The participants rated their *fear of asking for help* and *worth of statistics* components lowest, demonstrating apprehension in seeking assistance from professors and peers as well as a tendency to undervalue the importance of statistics in their field of discipline. The findings provide additional empirical evidence that SA sharply increases the prevalence of negative attitudes regarding statistics. Furthermore, Perepiczka et al. (2011) found that attitude toward statistics directly correlated with SSE and worth of statistics inversely correlated with SA, while SA and SSE may also affect student success by impacting student motivation.

Knowledge and application of statistical software among business professionals is a critical competency that enhances their decision-making process. Hsua et al. (2009) conducted a quantitative study of 207 online Masters of Business Administration students from a large Midwestern university to determine the impact of motivation and anxiety regarding statistical software. Using a modified technology acceptance model, the findings of the study revealed that positive computer attitudes and high levels of SSE resulted in more positive perceptions toward the usefulness and ease of use of statistical software. As a result, the researchers correlated high perceived usefulness and ease of use among students to the use of the statistical software. The results of this study indicate that motivation and the perceived usefulness of the subject may mediate anxiety.

Metacognition may be another way in which SA and SSE relate. Research evidence points to a possible relationship between anxiety, self-efficacy, and cognition in statistics classes. Younesi et al. (2014) studied the relationship between SSE and SA among university students in Iran to assess the relationship between metacognition, SA, and SSE. Using a random sample of 320 college students, the researchers used the Emotional Self-Efficacy Scale, Meta-Cognitions Questionnaire, and Statistical Anxiety Scale (SAS) to measure the variables. Furthermore, they conducted inferential statistics (particularly, means), standard deviation, Pearson correlation, and stepwise regressions to analyze the data. The results established a significant negative relationship between emotional self-efficacy and SA. Additionally, they found a negative relationship between metacognitive beliefs and SA. Hsua et al. (2009) identified a relationship between SA and SSE with motivation, which demonstrated that metacognition may be another mediating factor to consider. Overall, this evidence provides a further linkage between SA and SSE.

Rastegar et al. (2015) conducted a correlational study to explore the relationship of SSE, statistics achievement goals, and SA among undergraduate students at a Malaysian university. They randomly selected 320 students through cluster sampling. The researchers conducted confirmatory factor analyses to determine whether performance-avoidance behaviors among students affected their achievement in statistics courses. The path analysis results indicated that SA and SSE were mediating variables, which influenced the students' achievement scores in statistics. Therefore, performance-avoidance behavior may be another variable linking SA and SSE, along with motivation and metacognition (Hsua et al., 2009; Younesi et al., 2014).

Studies have demonstrated that previous experience and performance in mathematics affects statistics achievement scores or overall performance in the course (Bill, 2003; Bui & Alfaro, 2009). Larwin (2014) investigated the relationship between SSE and prior mathematics experience to understand these relationships better. She employed a structural equation modeling method, the Current Statistics Self-Efficacy (CSSE) measure, using an instrument constructed by Finney and Schraw (2003). The model established a significant relationship between SE (CSSE scores) and students' previous mathematics experience. The number of mathematics classes previously taken significantly correlated to the students' SSE. Therefore, previous mathematics experiences may affect the relationship between SA and SSE. This outcome is consistent with the results Bui and Alfaro (2009) and Bill (2003) obtained, when they found that adult students struggled with statistics content due to the extended time from which they had last taken a mathematics class. These studies together provide evidence that prior mathematics experience may be a significant factor regarding SSE.

Students with high levels of SA and low levels of SSE are liable to struggle with and consequently earn poorer scores in statistics courses (Andrew et al., 2009; Beall et al., 2015; McMullan et al., 2012; Perepiczkaet al., 2011). Additionally, these students may struggle with SA and SSE concepts, which interact to impact the attitudes and achievement levels of students. These can only be mediated by motivation and perceived usefulness (Hsua et al., 2009), performance-avoidance behavior (Rastegar et al., 2015), and metacognition (Younesi et al., 2014).

Attrition Rates in Nursing

Attrition ranks as a top concern in nursing education, exacerbating the existing nursing shortage. Researchers Pryjmachuk et al. (2009) assessed why some students did not complete the requirements to earn a degree using a retrospective cohort study of 1,259 nursing students at a large U.K. university. The researchers found that older students were more likely to complete the program than their younger counterparts. They followed four cohorts throughout the study from the 2002–2003 academic year to the students' graduation in 2006. Overall, the proportion of non-completers was over 25% in each cohort. Students were more likely to complete the program if they were older upon entering it. Using logistic regression modeling, the researchers found that for each additional year after 20 years old, the odds of completion increased by 1.04. Therefore, a student aged 40 at the time of entry would have over twice the odds of completing the program than a student aged 20 at matriculation. The results indicated that academic stress is associated with attrition, but that coping is a mediator for the effect of stress. Moreover, self-efficacy played a significant role in the nursing attrition rates of the students included in the study (Pryjmachuk et al., 2009).

Additionally, students with only the minimum qualifications for acceptance into the program were less likely to complete the program than students with higher-level qualifications. Course structure and curriculum also affected the drop-out rate; therefore, Pryjmachuk et al. (2009) suggested further flexibility in the curriculum as a manner in which to improve attrition rates.

In another study coming out of the U.K., Urwin et al. (2010) conducted an integrative literature review on nursing attrition rates in the United Kingdom and identified several factors contributing to nurses leaving the profession, including individual, institutional, and professional factors. Individual student factors included academic capability, personal preferences, and individual circumstances. The researchers found that students' failure in examinations indicated their academic capability, which also linked to low educational standards. Institutional factors included issues within the university, such as clinical placement, curriculum, and class size. Professional factors included funding, policy, and job security.

Urwin et al. (2010) posited that attrition in nursing programs was positive because it helps to maintain high standards within the profession. Given this, they suggested that there is an ethical and professional benefit to the high levels of attrition currently seen in nursing education. They explained that, because there is no central record for attrition in education and no standardized methods for how to accurately calculate it, there may be discrepancies in how to measure student attrition levels.

Due to the demands of the profession and expectations for quality of care, nursing programs provide strict academic standards. Rouse and Rooda (2010) stated, however, that even with such standards, many of the programs in the U.S. do not meet the expectations of the nursing accreditation agencies. These researchers conducted a mixed-method study of 39 students enrolled in a Midwest nursing school's accelerated RN to BSN program. They obtained demographic information, academic history, admissions records, transcripts, and exit interviews that related to attrition rates of full-time students enrolled in the RN to BSN program. Rouse and Rooda found that factors, including the demands of the profession, the quality of care, and the strict retention standards in the nursing program were barriers to success for many of the students. This outcome is significant because it demonstrated that factors unrelated to curriculum, pedagogy, or anxiety levels may lead to higher attrition rates in nursing program.

Aside from a lack of academic fitness, anxiety is a well-documented cause of stress among nursing students. Higginson (2006) conducted a qualitative study using a grounded theory research design, which examined the stress experienced by first-year nursing students at the University of Glamorgan in South Wales. The student investigator used purposive sampling to gather information from five students, each of whom were interviewed twice for 45 to 60 minutes. The students shared information that related to their sources of stress and anxiety in their nursing courses. In addition to fears about patient deaths, clinical procedures, finances, role, and socialization conflicts, students expressed anxiety over examinations, especially in physical science subjects, including statistics.

As Higginson (2006) noted, one source of stress that students experience is due to test anxiety. Students who experience it have weakened academic performance. Sharif and Armitage (2004) used a sample of 100 second and fourth-year undergraduate nursing students from Shiraz University of Medical Sciences in Iran to assess the effect of counseling in reducing anxiety in nursing students. The researchers randomly assigned 50 students to the experimental group and provided them with a 12-week intervention; they placed the other 50 students in a control group. After one semester, students in the experimental group had statistically significant lower anxiety, higher self-efficacy, and improved GPA. These changes indicated that an intervention lasting for 12 weeks was enough time in which to impact academic anxiety in nursing students. Furthermore, doing so may improve nurses' overall academic success, ultimately leading to lower attrition rates.

Overall, SA may be one of the most significant contributing factors concerning why students drop out of nursing programs. Therefore, it is essential to recognize the interactive effect of anxiety and self-efficacy when accounting for student achievement and attrition indicators. Moreover, it is vital to consider the individual, institutional, and professional reasons why a student may choose to leave a program and to identify the qualifications that the student may have lacked when they initially enrolled. These factors may also interact with the student's anxiety and self-efficacy levels. When examined together, these data may provide insight into why a student may not complete a nursing program. Therefore, student attrition may relate to a variety of factors, which schools should evaluate individually and collectively.

Summary

Statistics is a course that often rouses worry, fear, and anxiety among students (Andrew et al., 2009; Beall et al., 2015; McMullan et al., 2012). These factors are even more pronounced in non-mathematics-oriented disciplines (Higginson, 2006; Pourmoslemi et al., 2013; Welch et al., 2015). Studies have established that there is a significant correlation between student characteristics, such as SA, SSE, and type of learner (Baloğlu, 2003; Bell, 2003; Bui & Alfaro, 2009). This literature review revealed that no researchers have expressly examined SA among nursing students and its relationship with self-efficacy, thus warranting the implementation of the present study.

The underlying causes of SA in adult nursing students include general mathematics anxiety, attitude concerning statistics, cognition, and avoidance behaviors (Bull, 2009; Hsua et al., 2009; Macher, Paechter, Papousek, & Ruggeri, 2012; Rastegar et al., 2015; Sharif & Armitage, 2004; Younesi et al., 2014). These could impact nursing students, especially concerning dosage calculation ability (Andrew et al., 2009; Beall et al., 2015; Choundary & Malthus, 2017; Glaister, 2007; McMullan et al., 2012; Melius, 2012). A student's previous mathematics experience may also impact anxiety and self-efficacy levels (Larwin, 2014). Furthermore, self-efficacy, anxiety, and type of learner impact the attrition rates, which adversely affect the size of the nursing population (Pryjmachuk et al., 2009; Rouse & Rooda, 2010; Urwin, 2010). Therefore, if it is possible to decrease a student's SA and improve that student's SSE, these changes could effectively improve the student's academic performance in a statistics course and ultimately in the nursing program.

CHAPTER 2

Empirical Examination of Statistics

Anxiety and its Underlying Causes

Macher, Paechter, Papousek, and Ruggeri (2012) posited that SA is a situation-specific form of anxiety that describes apprehension that occurs after educators expose individuals to statistical problems, contents, evaluative context, or instructional situations. Consequently, they described SA as an enduring, habitual type of anxiety. Additionally, up to 66% to 80% of graduate students reported unmanageable levels of SA (Mji & Onwuegbuzie, 2004).

Introduction

Onwuegbuzie and Wilson (2003) reported that most undergraduate and graduate nursing degree programs require students to enroll in quantitative research and statistics courses. Accordingly, SA has become an issue of concern in higher education due to its implications for teaching and learning (Macher, Paechter, Papousek, & Ruggeri, 2012). Similarly, Onwuegbuzie (2004) found that SA is pervasive in fields of study, such as psychology, sociology, education. Students in these fields identify statistics courses as the most anxiety-inducing courses in their school curriculum. Students who usually choose these fields of study may have a slight interest in mathematics and statistics, and underestimate the extent to which statistics knowledge is necessary for their major (Ruggeri, Diaz et al., 2008). Macher, Paechter, Papousek, and Ruggeri's (2012) research reaffirmed that statistics courses were the primary source of anxiety students' curriculum. However, basic statistics classes are essential for non-statistics majors, as they may provide the only opportunity for them to learn skills that relate to research methods and analyses (Mji & Onwuegbuzie, 2004).

Moreover, SA is multidimensional and comprises six primary components (Cruise et al., 1985). These components include students' feelings about the worth of statistics, interpretation anxiety, test, and class anxiety, computational self-concept, fear of asking for help, and fear of statistics educators (Cruise et al., 1985; Earp, 2007). Also, SA relates to other factors, including mathematics self-concept, academic major, number of college mathematics courses completed, academic status, and perception of a student's previous success in mathematics courses (Onwuegbuzie, 2004).

Attitudes toward statistics and SA correlate highly. Moreover, the research shows that students who had negative experiences in mathematics or statistics were afraid of statistics and exhibit symptoms of SA (Mji & Onwuegbuzie, 2004). Further evidence is provided by Dykeman's (2011) study, which investigated the levels of anxiety between students in statistics courses and those in other non-statistics courses in a University's education department. Researchers have shown that students' perceived self-efficacy impacts anxiety, attitude, and achievement in their college statistics classes (Finney & Shraw, 2003; Perepiczka et al., 2011).

Goals and Objectives of the Research

The student investigator conducted a needs assessment to determine the measures that she would use to examine the anxiety levels of graduate students in an advanced research theory course. Consequently, she used statistical methodology and data analysis methods. Furthermore, she used the Statistics Anxiety Measure (SAM). (A copy of this instrument is in Appendix A.) The main objective of this study was to test the survey tool to establish its effectiveness in measuring anxiety that relates to statistics coursework.

Context

Accreditation standards require all nursing students to take one statistics course at the undergraduate level, as well as an advanced research theories course using statistics methodology at the graduate level. The student investigator of this study evaluated the behavior of students who expected to take statistics as one of their first classes in a nursing program. The student investigator found that many students withdraw from their statistics class or even drop out of the nursing program due to the high anxiety levels they experience in the statistics course. Students will often ignore the program's protocol and delay taking statistics until it is one of the last courses they take to complete their degree.

Moreover, students often withdraw from the class after only the first week, and they may enroll multiple times before finally taking the course to its completion. On end-of-course evaluation surveys, numerous students leave responses such as, "I have never been good at mathematics, so I knew that I wouldn't be good at statistics, and that makes me very anxious about taking this course." Both undergraduate and graduate nursing students enrolled in statistics courses express high levels of SA as well as low mathematics self-efficacy. Therefore, it is valuable to investigate the sources of anxiety experienced by nursing students to address the attrition levels that were described in Chapter 1.

The student investigator sampled student volunteers from the Educational Doctorate (EdD) program at the Johns Hopkins University. The purpose of this assessment was to evaluate the SAM's effectiveness as a survey instrument for assessing SA levels in graduate students who were in non-mathematics-based majors. The Johns Hopkins University Institutional Review Board (IRB) placed restrictions on this study, so they limited the student investigator to this convenience sample. Furthermore, the sampled participants were not part of the target population. Instead, they were graduate students enrolled in a research methodology course requiring statistics proficiency. Therefore, SA still applied to this population. The results of this study were generalizable to the nursing student populations, as the demographics, pre-requisites, and contexts were similar. The sampled students and the targeted population were not in statistics or mathematics degree programs. However, each program required students to use analytic reasoning skills and to conduct data analyses.

Additionally, both programs catered primarily to adult students who worked and attended school full-time concurrently.

Purpose

The student investigator hypothesized that SSE elements and type of learner relate to SA. Moreover, she theorized that adult learners (24 years and over) would report higher levels of SA and lower levels of SSE than traditional learners (18–23 years old). Additionally, the student investigator postulated that SSE would negatively relate to SA, which meant that traditional learners who had high levels of SSE would have lower SA. Conversely, it was hypothesized that traditional learners who had low levels of SSE would have higher SA. Due to the negative relationship between adult learners and SSE, the student investigator expected that adult learners would have lower SSE, and hence, higher SA. The goal of this study was to investigate the relationship between SA and student characteristics (SSE and type of learner) in the context of graduate students in a research methodology course. Additionally, the student investigator included the alignment between each of the research questions and the items from the survey instrument in Appendix B.

The research questions were:

1. How does anxiety impact graduate student performance in statistics classes?
2. Does a student's attitude toward statistics affect their academic performance in the research methods course?
3. How does the type of learner affect the likelihood that an individual will have SA?

Methodology

This investigation was a cross-sectional study where the student investigator intended to collect preliminary information related to graduate student anxiety levels in an advanced research theories course that used statistics methodology. In this initial stage, the student investigator collected data from an outside source to verify the effectiveness of the study design and survey instrument. The rationale for the student investigator selecting a cross-sectional study was that she expected this method to provide sufficient information to address the goals and objectives of the research.

One of the advantages of cross-sectional studies is that they are inexpensive and quick to implement (Mann, 2012). These studies do not need the researcher to follow up. Therefore, it requires fewer resources to run such a study (Levin, 2006). According to Mann (2012), cross-sectional studies are the best way to determine the prevalence of SA. They are useful for identifying associations that the researcher could then rigorously analyze using a cohort or randomized controlled study. However, a caveat is differentiating cause and effect from a basic association in cross-sectional studies (Song & Chung, 2010). Thus, the student investigator used the results of the needs assessment to establish the incidence of anxiety among students in an undergraduate nursing program at a large Southern California university. Moreover, she used the results to create an intervention aimed at reducing student anxiety in statistics and advanced research theories courses within the nursing program at the same university.

The cross-sectional study process began with the student investigator formulating the research questions and selecting an appropriate sample representative of the target population. The actual research population comprised of nursing students. However, the needs assessment investigated the anxiety levels of graduate students in an education program. The student investigator collected demographic data and calculated descriptive statistics for each domain to analyze the data she collected from the SAM. The data included feelings about the worth of statistics, interpretation anxiety, test, and class anxiety, computational self-concept, fear of asking for help, and fear of statistics educators.

Participants

The study participants were doctoral students in education (EdD) at the Johns Hopkins University. All participants were in a graduate research methods course in the Spring semester of 2016. Eighteen participants responded within the two weeks that the survey was open. Of those, 77.8% (n=14) were female, and 22.2% (n=4) were male. Sixteen participants identified themselves as White, one who identified as African American, and one who identified as Middle Eastern. The respondents ranged in age from 25 to 54, with an average age of 37. The student investigator categorized the participants into four age ranges: 20–29 (n=3), 30–39 (n=9), 40–49 (n=3), and 50–59 (n=3).

Measures and Instrumentation

The student investigator assessed SA using the SAM. SAM is a six-part survey created and validated by Earp (2007) that uses classical test theory and item response theory for researchers to assess convergent validity and any differences based on demographic groupings. Additionally, the student investigator measured correlations with other known SA measures—including the STARS and Survey of Attitudes Toward Statistics (SATS)—and found them internally consistent and reliable.

The SAM test domains include general SA, attitudes regarding class, attitudes toward mathematics, and expected level of performance (Earp, 2007). The first of the survey's six parts comprises six demographic questions that relate to gender, race/ethnicity, age, major, minor, and degree program. Sections two through six ask questions that relate to the four different domains identified for SA, including anxiety, attitudes concerning class, attitudes about mathematics, and expected level of performance. Answer choices for all sections were ordinal and follow a four-level Likert-type scale (1–*not anxious* to 4–*very anxious*; 1–*strongly disagree* to 4–*strongly agree*; 1–*average* to 4–*fail*).

The general SA domain comprises factors that relate to statistics content anxiety, statistics test anxiety, class anxiety, interpretation anxiety, test anxiety, mathematics anxiety, mathematics test anxiety, numerical anxiety, and lack of mathematics foundation (Earp, 2007). Students who scored high in the general SA domain self-reported feeling anxious in class situations involving tests, mathematics, numbers, statistics, and the process of interpreting results they derive from empirical data. This domain includes items that relate to statistics test and class anxiety, which refer to the anxiety that affects students when they are in class or taking a test (Cruise at al., 1985). Interpretation anxiety is another component of this domain, referring to the anxiety that students feel when instructors ask them to make decisions from or interpret statistical data. Numerical anxiety and lack of mathematics foundation integrate into the component of computation self-concept, relating to the anxiety that students experience when they try to solve mathematical problems (Cruise et al., 1985).

The attitude toward the class domain addresses the perceived worth of statistics (Earp, 2007). Students with high scores in this domain typically expect a boring and useless statistics class and "will feel anxious in class situations involving tests, mathematics, numbers, statistics, or in the process of interpreting results derived from empirical analysis" (Earp, 2007, p. 28). This domain includes concepts that relate to the perceived worth of statistics, which refers to the students' perceptions of how useful and relevant they find statistics (Cruise et al., 1985).

The attitude regarding mathematics domain addresses numerical anxiety, the student's mathematics reasoning ability, past experiences with mathematics course material, and peer pressures and expectations for success in mathematics. Students with high scores in this domain often dislike working with numbers and may experience feelings of helplessness and despair in solving mathematical problems. The student's previous experiences define this domain in mathematics classes, and the perceived instruction, quality, difficulty of those classes (Earp, 2007).

The expected level of performance domain focuses on topics that relate to social norms and expectations, motivation to continue learning, and cognition. This domain is evaluated based on student self-reports regarding their course performance, ability to perform statistical operations, and ability to learn statistical concepts (Earp, 2007). Students with high scores display unrealistically high parental/peer pressures to succeed in mathematics and high expectations of punishment for failure to meet demands in mathematical-solving situations. This pressure may be due to an unfortunate experience with mathematics course material or a low level of mathematical reasoning ability (Zeidner, 1991).

Reliability and Validity of the Statistics Anxiety Measure and Self-Efficacy to Learn Statistics

The SAM and the Self-Efficacy to Learn Statistics (SELS) scale remain the most dominant tools researchers use to determine the level of fear and personal efficacy that prevents students from performing favorably in statistics and related courses. Although they provide useful information in this domain, their reliability and validity are of importance in knowing whether they are efficient tools compared to other methods. The SAM has a high construct validity and internal consistency reliability, with a Cronbach's coefficient alpha of 0.82-0.95 (Vahedi, Farrokhi, & Bevrani, 2011). A study that Liu et al. (2011) conducted, confirmed the reliability of the SAM among Chinese students showed that the internal consistency values of the study were consistent with the results of four similar studies that the researchers conducted in the same manner. Furthermore, a study by Swingler and Morrow (2014) found that the SAM and the SELS tools were reliable and that their use could help change course designs, teaching methods, and other approaches to reduce anxiety and increase students' efficacy to improve performance.

A study conducted by Vahedi, Farrokhi, & Bevrani (2011) also support the fact that the SAM has a reliable and valid approach to SA, as their results were consistent with a previous study showing that SA is significant across gender. Additional research that Chiesi et al. (2011) conducted found that they could replicate the results of SAM across countries using the same method of measure among students. The STARS and SAS are some of the most commonly-used tools that researchers used to measure SA and SSE. Chew and Dillon (2014) conducted additional research where they determined that SAS is a better tool in determining SA, while STARS is essential for providing information concerning attitude and personal factors that determine a student's performance in statistics. The SAM combines elements from the SAS and the STARS and provides information on SA, attitudes, and personal factors.

Perepiczka et al.'s (2011) study showed that there is a convincing indirect correlation between SA and SSE. Although the SAM design by Earp (2007) provides a model for measuring SA, Chew and Dillon's (2013) study, as well as Chiesi et al. (2011), found that SAS provides a precise way of measuring SA. However, the SAM is still superior to SAS for assessing SA because of its high internal consistency, generating a Cronbach's coefficient alpha of 0.90 (Vahedi, Farrokhi, & Bevrani, 2011). The SELS tools are reliable, even for studies requiring a large number of subjects. Additionally, they provide a clue as to the effect of SA, which indicates the usefulness of these tools (Perepiczka et al., 2011). Therefore, in this study, the student investigator used the SAM to assess SA and the SELS to measure SSE.

Procedure

The student investigator sent a message by email to students in their third trimester of a doctorate program in education, asking for voluntary participation as part of a needs assessment. The students first received an email about the nature of the study, followed one day later by an email with the informed consent form and a link to the survey, which was open for two weeks. The student investigator sent out a reminder email between the first and second week that the survey was open.

The survey included information on demographics, SA, general mathematics anxiety, and which types of assessments induce the highest amount of anxiety. The student investigator calculated the aggregate scores for each participant in each section to analyze the data. Using descriptive statistics, she explained the participants' demographic characteristics, as well as quantified the students' SA, consistent with each of the four domains. The student investigator performed chi-square tests to explore further socio-demographic variables, such as ethnicity, gender, and age associated with levels of SA. Then, she used the results of the survey to map and correlate the quantitative data accurately.

The main objective of this study was to test the survey tool, while the goal was to test the effectiveness of this tool to collect responses of students' SA levels. Therefore, it was essential to ensure that the questions were clear, the format was user-friendly, and the response choices included enough variety to capture the genuine anxiety levels of the students in the sample. Furthermore, the student investigator reviewed the data for general trends in academic anxiety from this sample, as well as for differences in anxiety levels that she could identify as gender-based.

Results

The student investigator sent the survey to 60 students in their first year of a graduate-level program in education. Eighteen of those students volunteered to participate. Then, 17 opened the link and completed the online survey, indicating a response rate of 28%.

The four domains tested by the SAM included anxiety, attitudes concerning class, attitudes toward mathematics, and expected level of performance. The student investigator conducted frequencies and results for the chi-square test of independence to see if gender related to anxiety level.

Gender and Anxiety

The chi-square test of independence showed that statistically significant gender differences existed in several variables for the anxiety domain (see Table 2-1).The sample include 14 female students and only four male students. Nevertheless, the student investigator examined anxiety's effect on gender because the sample's male to female ratio was consistent with the target population. (The nursing program was primarily made up of females, with a ratio of about 75% females to 25% males, as in the sample from the education cohort.) Therefore, it was possible to investigate the relationship between gender and SA in this needs assessment and use these findings to predict what the student investigator may observe in the target population.

The student investigator also discovered statistically significant differences in one variable of the expected level of performance domain for explaining answers (p=0.044) (see Therefore, the results the student investigator obtained here may not describe the target sample accurately, creating a potential threat to the generalizability of the results. Another limitation that may have affected the results is that the student investigator gave out the survey in the middle of the semester. Therefore, students knew how well they were doing in the class, potentially impacting the measures of self-efficacy and anxiety. Additionally, a larger sample size of students would have helped analyze distinct experiences by age. The lack of variability in these participants made it challenging to analyze demographic trends that relate to age, gender, and race/ethnicity.

The goal of this study was to test the survey instrument to ensure that it would be useful for measuring the anxiety levels of students in a statistics course. The results indicate that graduate students in a research methods class in an education program experienced SA.

Table 2.5). She did not identify any significant gender effects in this sample due to attitudes about mathematics (see Table 2.3) or attitudes concerning class (see 2.4) . These include anxiety that relates to having to explain statistical findings ($p=0.039$), interpreting statistics ($p=0.006$), and taking statistics courses ($p=0.035$).

Students' anxiety was affected by various factors in this sample. When the survey asked participants about the level of anxiety that they experienced when taking tests in the class, 17.6% (n=3) reported that they were not anxious, 29.4% (n=5) reported they were anxious, and 23.5% (n=4) reported that they were very anxious (see Table 2.5).

Age and Anxiety

Results were stratified by age to investigate the effect of age on SA, exploring four categories: 20–29 (n=3), 30–39 (n=9), 40–49 (n=3), and 50–59 (n=3). The student investigator conducted frequencies and results for the chi-square test of independence for each age category, and each question from the SAM. A significant relationship existed between age and the anxiety domain for the statement, "I am worried about taking statistics" (see Table 2.6). The student investigator observed a significant relationship between age and the attitudes toward class domain for the statement, "I will never use what I learn in this class again" (see Tables 2.7 and 2.8). In both cases, the student investigator observed the highest frequencies in the 30–39 year-old group. No significant relationships were identified between age and the domains for attitudes regarding mathematics (see Table 2.9) or the expected level of performance (see Table 2.10).

These results support the hypothesis that students are worried about taking statistics and become anxious upon hearing that it is a requirement for their program. The students in this study were majoring in education, which is a non-mathematics major. Therefore, they may not have initially been aware that their program would require them to take a statistics-based course. These results also indicate that students may not recognize the value that statistics and research methods skills could contribute to their education.

Students also reported feeling most anxious about taking tests and interpreting statistical results (see Table 2.10), indicating that curriculum components could affect SA levels. Additionally, the type of student (adult or traditional age) does appear to affect SA levels. In this study, the student investigator observed gender and age differences, which supports the hypothesis that the type of student (adult or traditional age) could interact with anxiety levels to impact overall achievement in the course.

Table 2.1

Gender Influence on Anxiety Levels of the Participants

Anxiety question	Gender	Not anxious	Slightly anxious	Anxious	Very anxious	χ2 (p)
Taking tests in this class	Female	1	4	3	4	4.68 (0.32)
	Male	2	1	1	0	
Explaining your statistical findings	Female	4	1	0	7	8.39 (0.04)*
	Male	1	3	0	0	
Formulating and testing	Female	2	2	2	6	5.89 (0.21)
hypotheses	Male	2	2	0	0	
Interpreting statistics	Female	0	5	0	7	12.37 (0.01)*
	Male	3	1	0	0	
Taking statistics	Female	4	3	0	5	10.33 (0.04)*
	Male	0	2	2	0	
Calculating probabilities	Female	2	2	3	5	3.57 (0.57)
	Male	2	1	1	0	
Developing conclusions based on mathematical solutions	Female	3	2	2	5	3.60 (0.47)
	Male	1	2	1	0	
Reading statistical studies	Female	2	5	3	2	2.64 (0.62)
	Male	2	1	1	0	
I am worried about taking statistics	Female	2	3	4	4	2.92 (0.40)
	Male	0	2	2	0	
Based on past experiences, I expect the material to be hard	Female	1	1	5	6	5.35 (0.15)
	Male	0	2	2	0	
I worry about doing well in this class	Female	0	4	2	7	4.03 (0.13)
	Male	0	2	2	0	
I've struggled to follow the material covered in the past	Female	0	3	4	6	7.47 (0.06)
	Male	1	0	3	0	

*significant ($p < 0.05$)

Note. The chi-square test of independence shows that statistically significant gender differences exist in several variables for the anxiety domain.

Table 2.2

Gender Influence on Expected Performance Levels of the Participants

Performance question	Gender	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
If there was a way I could avoid taking this class I would	Female	1	4	4	4	2.18 (0.54)
	Male	0	2	2	0	
I do not expect to enjoy this class	Female	0	5	5	3	1.12 (0.57)
	Male	0	2	2	0	
I expect this class to be boring	Female	0	7	5	1	3.72 (0.29)
	Male	1	2	1	0	
I am only taking this class because it's required	Female	0	1	5	6	3.90 (0.27)
	Male	0	2	1	1	
I will never use what I learn in this class again	Female	4	9	0	0	0.495 (0.48)
	Male	2	2	0	0	
My ability to calculate statistics will not affect my chances of getting a job	Female	1	7	3	2	2.69 (0.44)
	Male	1	1	2	0	
I lack motivation to learn or continue learning statistics	Female	2	7	3	1	0.481 (0.92)
	Male	1	2	1	0	
Taking this class will have little impact on my life	Female	1	8	4	0	2.09 (0.35)
	Male	1	3	0	0	
There is no room to be creative in statistics	Female	4	5	4	0	3.03 (0.22)
	Male	3	0	1	0	

Note. The sample had no significant gender effects due to attitudes concerning class.

Discussion

The student investigator conducted this needs assessment to determine if the SAM would be useful in analyzing anxiety levels. Significant effects were observed for various domains that relate to SA. These effects indicate that the SAM would be useful in gathering self-reported data on SA. Furthermore, the effect gender has on anxiety is salient, as research indicates that females have higher levels of anxiety and lower levels of self-efficacy in statistics courses (Onwuegbuzie & Wilson, 2003). The intended population was students in an undergraduate nursing program; however, the needs assessment sampled graduate students in education. Both populations have a more significant proportion of females than males. Therefore, the results from this needs assessment support the possibility of identifying the relationship between gender and SA, even with the smaller sample size for men, as this is still representative of the target population.

Table 2.3

Gender Influence on Attitudes Toward Class of the Participants

Class attitude question	Gender	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
I was hesitant to register for this class	Female	1	4	6	1	2.05 (0.73)
	Male	1	2	1	0	
I am afraid to ask for help	Female	2	4	6	0	4.085 (0.40)
	Male	1	1	1	1	
I have been worried ever since I was informed this was a requirement	Female	2	4	4	2	0.69 (0.95)
	Male	1	1	1	1	
I am only taking this class because it's required	Female	2	5	3	2	1.65 (0.80)
	Male	1	2	1	0	

Note. The sample had no significant gender effects due to attitudes concerning class.

Many students reported feeling anxious about taking tests in their Research Methods I class (see Table 2.10), a statistics and research-based course for graduate education students. This response was thought-provoking because, currently, the curriculum for the research methods course does not contain any tests. Therefore, one would expect the students to report that they were not anxious about tests in the class. However, in Research Methods I, students conduct statistical analyses using computer software, such as SPSS and then write up their findings in a research paper. In the course, the analyses they run are on various statistical tests. Therefore, they possibly interpreted the word tests differently than how the student investigator intended in the survey, where it referred to examination-based assessments.

Limitations

The SAM had limitations assessing SA affecting the validity of the results. The validated survey is the instrument that researchers use to assess the causes of anxiety and the level to which students experience anxiety in statistics courses (Earp, 2007). However, there was a threat to the external validity of this needs assessment study because the sample the student investigator used in the pilot study did not represent the intended target population for the intervention. The target university long-delayed the IRB process, ultimately limiting the ability to examine the context in which the student investigator could conduct the intervention study.

Table 2.4

Gender Influence on Attitudes Toward Mathematics of the Participants

Math attitude question	Gender	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
My math reasoning ability is low	Female	3	4	5	0	0.79 (0.85)
	Male	1	2	1	0	
Math is my least favorite subject	Female	3	4	4	1	0.98 (0.91)
	Male	1	2	1	0	
I dislike math	Female	3	4	4	1	0.98 (0.91)
	Male	1	2	1	0	
I've never enjoyed working with numbers	Female	3	4	4	1	1.44 (0.84)
	Male	2	1	1	0	
I am not good with math	Female	3	4	4	1	3.30 (0.51)
	Male	1	3	0	0	
I have never enjoyed classes that involve math	Female	2	6	3	1	3.11 (0.54)
	Male	2	2	0	1	
I dislike working with numbers	Female	3	4	4	1	2.921 (0.57)
	Male	2	2	0	0	
I have low self-esteem when it comes to math	Female	3	1	6	2	1.58 (0.81)
	Male	1	1	1	1	
Math is the subject where I have the least amount of confidence	Female	2	2	6	2	4.03 (0.401)
	Male	2	1	0	1	
My least enjoyable experiences in school involved math	Female	4	4	3	1	0.98 (0.91)
	Male	2	1	1	0	

Note. The sample had no significant gender effects due to attitudes about mathematics.

Therefore, the results the student investigator obtained here may not describe the target sample accurately, creating a potential threat to the generalizability of the results. Another limitation that may have affected the results is that the student investigator gave out the survey in the middle of the semester. Therefore, students knew how well they were doing in the class, potentially impacting the measures of self-efficacy and anxiety. Additionally, a larger sample size of students would have helped analyze distinct experiences by age. The lack of variability in these participants made it challenging to analyze demographic trends that relate to age, gender, and race/ethnicity.

The goal of this study was to test the survey instrument to ensure that it would be useful for measuring the anxiety levels of students in a statistics course. The results indicate that graduate students in a research methods class in an education program experienced SA.

Table 2.5

Gender Influence on Fearful Behavior of the Participants

Fearful behavior question	Gender	Above average	Average	Below average	Fail	$\chi2$ (p)
Developing appropriate methodology to test a given hypothesis	Female	0	5	7	0	4.20 (0.24)
	Male	1	2	1	0	
Solving equations using the calculator/computer	Female	3	3	6	0	3.66 (0.30)
	Male	2	2	0	0	
Projects	Female	2	6	4	0	5.57 (0.14)
	Male	3	1	0	0	
Making accurate conclusions	Female	2	6	4	0	2.18 (0.54)
	Male	1	3	0	0	
Exams	Female	1	8	3	0	0.706 (0.87)
	Male	0	3	1	0	
Explaining my answers	Female	0	8	3	0	8.11 (0.04)*
	Male	2	2	0	0	
Quizzes	Female	1	8	3	0	0.706 (0.87)
	Male	0	3	1	0	
Interpreting my answers	Female	1	5	6	0	1.52 (0.68)
	Male	1	2	1	0	

*significant ($p < 0.05$)

Table 2.6

Influence of Age on Anxiety Levels of the Participants

Anxiety question	Age	Not anxious	Slightly anxious	Anxious	Very anxious	χ2 (p)
Taking tests in this class	20–29	1	0	1	0	14.10 (0.30)
	30–39	0	2	3	3	
	40–49	1	2	0	0	
	50–59	1	1	0	1	
Explaining your statistical findings	20–29	0	1	0	1	8.28 (0.51)
	30–39	0	2	2	4	
	40–49	0	0	2	1	
	50–59	0	1	1	1	
Formulating and testing hypotheses	20–29	1	1	0	0	16.70 (0.16)
	30–39	0	3	1	4	
	40–49	1	0	0	2	
	50–59	2	0	1	0	
Interpreting statistics	20–29	0	0	1	1	15.23 (0.09)
	30–39	0	1	2	5	
	40–49	0	2	0	1	
	50–59	0	3	0	0	
Taking statistics	20–29	0	2	0	0	15.69 (0.21)
	30–39	1	1	2	4	
	40–49	2	1	0	0	
	50–59	1	1	0	1	
Calculating probabilities	20–29	1	0	1	1	10.83 (0.54)
	30–39	1	1	0	4	
	40–49	1	1	0	0	
	50–59	1	1	0	0	
Developing conclusions based on mathematical solutions	20–29	1	0	0	1	12.05 (0.44)
	30–39	2	1	2	3	
	40–49	1	1	0	1	
	50–59	0	2	1	0	

Table 2.6 (cont.)

Influence of Age on Anxiety Levels of the Participants

Anxiety question	Age	Not anxious	Slightly anxious	Anxious	Very anxious	χ2 (p)
Reading statistical studies	20–29	1	0	1	0	15.52 (0.21)
	30–39	0	3	3	2	
	40–49	1	2	0	0	
	50–59	2	1	0	0	
I am worried about taking statistics.	20–29	0	2	1	0	17.58 (0.04)*
	30–39	0	1	4	3	
	40–49	2	0	0	1	
	50–59	0	2	1	0	
Based on past experiences, I expect the material to be hard.	20–29	0	2	0	1	14.57 (0.10)
	30–39	0	0	4	4	
	40–49	1	0	1	1	
	50–59	0	1	2	0	
I worry about doing well in this class.	20–29	0	2	1	0	6.02 (0.42)
	30–39	0	1	2	5	
	40–49	0	2	0	1	
	50–59	0	1	1	1	
I've struggled to follow the material covered in the past.	20–29	0	1	2	0	11.45 (0.25)
	30–39	0	1	2	5	
	40–49	0	0	2	1	
	50–59	1	1	1	0	

*significant ($p < 0.05$)

Table 2.7

Influence of Age on Levels of Performance of Participants

Performance question	Age	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
If there was a way I could avoid taking this class, I would.	20–29	0	1	2	0	
	30–39	0	3	2	3	9.86 (0.36)
	40–49	1	0	1	1	
	50–59	0	2	1	0	
I do not expect to enjoy this class	20–29	0	1	2	0	
	30–39	0	2	4	2	5.13 (0.53)
	40–49	0	2	0	1	
	50–59	0	2	1	0	
I expect this class to be boring.	20–29	0	1	2	0	
	30–39	1	4	2	1	3.78 (0.93)
	40–49	0	2	1	0	
	50–59	0	2	1	0	
I am only taking this class because it's required.	20–29	0	0	2	0	)
	30–39	0	2	2	4	
	40–49	0	0	1	2	9.38 (0.40
	50–59	0	1	1	1	
I will never use what i learn in this class again	20–29	3	0	0	0	
	30–39	1	7	0	0	10.25 (0.02)*
	40–49	0	3	0	0	
	50–59	2	1	0	0	
My ability to calculate statistics will not affect my chances of getting a job.	20–29	2	1	0	0	
	30–39	0	4	4	0	14.43 (0.06)
	40–49	0	2	0	1	
	50–59	0	1	1	1	
I lack motivation to learn or continue learning statistics.	20–29	2	1	0	0	
	30–39	1	4	2	1	11.88 (0.22)
	40–49	0	1	2	0	
	50–59	0	3	0	0	
Taking this class will have little impact on my life.	20–29	1	2	0	1	6.101 (0.41)
	30–39	1	6	1	1	
	40–49	0	1	2	0	
	50–59	0	2	1	0	

Table 2.7 (cont.)

Influence of Age on Levels of Performance of Participants

Performance question	Age	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
There is no room to be creative in statistics	20–29	2	1	0	0	
	30–39	2	2	4	0	6.80
	40–49	2	0	1	0	(0.34)
	50–59	1	2	0	0	

*significant ($p < 0.05$)

Conclusion

The student investigator assessed the four dimensions of SA using the SAM and analyzed the outcomes. The results indicate that researchers could use this instrument effectively to determine the type of activities, attitudes, and performance assessments responsible for SA. Moreover, the student investigator conducted this analysis using statistical methodologies with graduate-level students in an advanced research theories course. It was determined that the SAM could be useful in assessing levels of SA in nursing students taking statistics and advanced research theories courses.

Furthermore, the student investigator concluded that the SAM could be useful in identifying the activities in the course that were most likely to increase anxiety in the students. The results of this needs assessment are essential to statistics students, professors, and administrators in charge of curriculum development. They indicate that there is a relationship between SA and attitudes toward statistics in doctoral education students enrolled in a research methods course.

Ultimately, these results could help to identify ways in which instructors could develop a curriculum to support student learning in statistics courses while decreasing student anxiety. Because students in the needs assessment sample reported high levels of anxiety that relate to tests, it may be helpful to create alternate forms of assessments.

The data from this needs assessment provide evidence to illuminate the relationships among statistics activities, anxiety, attitudes, and performance expectations. This information has the potential to help researchers identify where efforts should be focused on when working to alleviate SA. The data the student investigator gathered could provide educators with information that they could use to create an intervention aimed at reducing student anxiety in statistics courses within a nursing department.

Table 2.8

Influence of Age on Attitudes Toward the Class of the Participants

Class attitude question	Age	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
I was hesitant to register for this class.	20–29	0	1	0	0	8.15 (0.11)
	30–39	1	2	5	1	
	40–49	0	0	2	0	
	50–59	0	3	0	0	
I am afraid to ask for help.	20–29	0	0	1	0	16.24 (0.18)
	30–39	1	1	5	1	
	40–49	0	1	1	0	
	50–59	0	3	0	0	
I have been worried ever since I was informed this was a requirement.	20–29	2	0	0	0	25.22 (0.01)*
	30–39	0	1	5	2	
	40–49	1	1	0	1	
	50–59	0	3	0	0	
I’ve avoided this class as long as possible.	20–29	2	0	0	0	19.70 (0.07)
	30–39	0	4	2	2	
	40–49	1	0	1	1	
	50–59	0	3	0	0	

*significant ($p < 0.05$)

Table 2.9

Influence of Age on Attitudes Toward Mathematics of the Participants

Math attitude question	Age	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
My math reasoning ability is low	20–29	1	1	0	0	13.16 (0.16)
	30–39	1	2	5	0	
	40–49	2	1	0	0	
	50–59	0	2	1	0	
Math is my least favorite subject	20–29	1	1	0	0	8.93 (0.71)
	30–39	2	2	3	1	
	40–49	1	1	1	0	
	50–59	0	2	1	0	
I dislike math	20–29	0	2	0	0	8.93 (0.71)
	30–39	2	2	3	1	
	40–49	1	1	1	0	
	50–59	1	1	1	0	
I've never enjoyed working with numbers	20–29	1	1	0	0	7.08 (0.85)
	30–39	2	2	3	1	
	40–49	1	1	1	0	
	50–59	1	1	1	0	
I am not good with math	20–29	1	1	0	0	11.13 (0.52)
	30–39	2	3	2	1	
	40–49	1	2	0	0	
	50–59	0	1	2	0	
I have never enjoyed classes that involve math	20–29	1	1	0	0	8.80 (0.72)
	30–39	1	4	2	1	
	40–49	1	1	1	0	
	50–59	1	2	0	0	
I dislike working with numbers	20–29	1	1	0	0	6.87 (0.87)
	30–39	2	3	2	1	
	40–49	1	1	1	0	
	50–59	1	1	1	0	
I have low self-esteem when it comes to math	20–29	1	0	1	0	13.26 (0.35)
	30–39	2	0	3	3	
	40–49	1	1	1	0	
	50–59	0	0	2	0	

Table 2.9 (cont.)

Influence of Age on Attitudes Toward Mathematics of the Participants

Math attitude question	Age	Strongly disagree	Disagree	Agree	Strongly agree	χ2 (p)
Math is the subject where I have the least amount of confidence	20–29	1	0	1	0	11.63 (0.48)
	30–39	1	2	2	3	
	40–49	1	1	1	0	
	50–59	1	0	2	0	
My least enjoyable experiences in school involved math	20–29	1	1	0	0	9.17 (0.69)
	30–39	2	2	3	1	
	40–49	2	1	0	0	
	50–59	1	1	1	0	

Table 2.10

Influence of Age on Fearful Behavior of Needs Assessment Survey Participants

Fearful behavior question	Age	Above average	Average	Below average	Fail	χ2 (p)
Developing appropriate methodology to test a given hypothesis	20–29	1	0	1	0	15.34 (0.08)
	30–39	0	3	5	0	
	40–49	0	1	2	0	
	50–59	0	3	0	0	
Solving equations using the calculator/computer	20–29	1	0	1	0	11.81 (0.22)
	30–39	3	1	4	0	
	40–49	1	2	0	0	
	50–59	0	2	1	0	
Projects	20–29	1	1	0	0	10.77 (0.29)
	30–39	2	2	4	0	
	40–49	1	2	0	0	
	50–59	1	2	0	0	
Making accurate conclusions	20–29	1	1	0	0	16.51 (0.06)
	30–39	0	5	3	0	
	40–49	2	0	1	0	
	50–59	0	3	0	0	
Exams	20–29	0	2	0	0	14.68 (0.10)
	30–39	0	4	4	0	
	40–49	1	2	0	0	
	50–59	0	3	0	0	
Explaining my answers	20–29	1	1	0	0	6.85 (0.65)
	30–39	1	4	2	0	
	40–49	0	2	1	0	
	50–59	0	3	0	0	
Quizzes	20–29	0	2	0	0	14.68 (0.10)
	30–39	0	4	4	0	
	40–49	1	2	0	0	
	50–59	0	3	0	0	

CHAPTER 3

Intervention Literature Review

The results of the needs assessment survey indicate that graduate education students experience significant levels of statistics anxiety (SA) relating to their attitudes toward statistics. The outcomes in Chapter 2 confirm the need for further examination of interventions that seek to relieve students' SA to improve their overall success and well-being. This chapter provides additional insight into the theoretical framework of the intervention and provides an overview of the intervention research literature.

In the first part of the chapter, the student investigator presents intervention strategies that aim to reduce SA and mathematical anxiety in college students. She describes the concept of SA and discusses the interventions that embrace the principles of social cognitive theory (Bandura, 1986) and social development theory (Vygotsky, 1978). Finally, she describes the studies that highlight the effects of a learner-centered approach in adult and nursing education.

Furthermore, this chapter emphasizes the strategies that succeed in the instructional and individual-levels to reduce students' SA and SSE. The student investigator illustrates how each of these diverse interventions impacts the classroom climate and a student's motivation. Moreover, the student investigator discusses strategies that apply to TBL and similar constructs. This chapter focuses on the advantages and benefits of TBL in nursing education and the problem institutions have when implementing TBL. Finally, the student investigator analyzes the TBL outcomes and determines the best methods for systematically assigning groups.

Nursing, like many other medical careers, is particularly stressful due to the challenges nurses experience daily. One of the most stressful times for nursing students is when they learn to apply theoretical concepts from the classroom setting to patients in the real world (Onwuegbuzie, 2004). For many students, they have pressure, anxiety, and apprehension made all the worse when their academic prowess is deficient compared to their colleagues (Finney & Schraw, 2003). Understandably, some careers are more demanding than others, but adapting the traditional pedagogy in nursing schools may alleviate many of these challenges.

These academic difficulties might be even more significant in nontraditional students, who are over the age of 25 (Jeffreys, 2007), resulting in high nursing program attrition rates among students (Gilchrest & Rector, 2007). These rates may be due in part to the expectations they have based on prior preparation in mathematics (Rudel, 2006). As a result, these adult nursing students are likely to avoid classes, like statistics, where they experience anxiety due to a fear of failure (Draves, 1986).

Overall, researchers consider SA as one of the main barriers to achieving success in statistics teaching and learning (Onwuegbuzie & Wilson, 2003). Accordingly, they currently seek to find ways of reducing SA to enhance statistics teaching by improving students' SSE (Larwin, 2014; McMullan et al., 2012). The development of successful SA reduction interventions holds the promise for students' increased academic achievement, as well as improved enrollment in statistics-related programs in institutions of higher education (Macher, Paechter, Papousek, & Ruggeri, 2012). Researchers have shown an array of intervention strategies that reduce SA among college students. They have considered cognitive and non-cognitive intervention strategies, though the majority of the research focuses on cognitive perspectives of the construct (Baloğlu, 2004; Ferla et al., 2009; Jansen et al., 2013).

In this literature review, the student investigator discusses various interventions that effectively reduce mathematics anxiety and SA in college students. Such interventions include increasing self-efficacy, value-reappraisal, vicarious experience, web-based instruction, increasing lecturer immediacy, using humor, religious motivation, TBL, and multifaceted techniques. This chapter explores each of those topics and evaluates their potential for use with adult nursing students who are enrolled in statistics-based courses.

Theoretical Framework

Students with high levels of SA may benefit from interventions that use socially-based teaching strategies so that students can work together to learn the concepts (D'Souza et al., 2013; Macke & Tapp, 2012). The theoretical foundation for the intervention the student investigator pursued follows the tenets of social cognitive theory (Bandura, 1986) and social development theory (Vygotsky, 1978).

Social Cognitive Theory

According to Bruning et al. (2011), social learning stems from a cognitive psychology theory that suggests that social interaction is vital and inevitable for learning to occur. Looking further into aspects of social learning, Ernest (2010) and Ertmer and Newby (1993) introduced constructivism with a focus on the use of objectives, graphic organizers, and essential questions. In constructivist thinking, students build up structures from pre-existing knowledge and experience and shape them together for the task at hand, creating meaning from experiences. Therefore, students learn best with constructivist strategy tasks that demand a high level of processing (Ertmer & Newby, 1993).

Social learning occurs when people have the opportunity to collaborate and share ideas. In social cognitive theory, Bandura (1986) asserts that human behavior varies based on the environment, including other participants in the environment and the individual's state of mind. Therefore, the social cognitive view applies to interventions that target SA. In social cognitive theory, factors impact whether or not the learner acquires and performs the observed behavior. In this context, attention is a crucial factor since it must focus on an appropriate model that is meaningful to the learner, so much so that the learner will want to emulate the behavior. Motivation is another factor that influences whether or not the learner will put the learned behaviors into practice (Bandura, 1986). Thus, interventions targeting SA should consider the effects of attention, motivation, and the student's environment.

Social Development Theory

One frequently discussed topic in pedagogy and educational psychology is the search for effective teaching strategies that help learners gain, retain, and apply knowledge. Researchers have often utilized Vygotsky`s (1978) sociocultural theory and his concepts of the Zone of Proximal Development (ZPD) and scaffolding to understand better and enhance the learning possibilities of students.

According to Lapkin et al. (2010), ZPD is "the difference between what an individual can do with the help of others and what that individual can do on their own" (p. 478). The instructor's use of pedagogical strategies to assist students in moving through the ZPD to help them solve a problem that they would not solve alone is metaphorically called *scaffolding* (Bonk & Kim, 1998; Fani & Ghaemi, 2011; Sanders & Welk, 2005). Although researchers predominantly use Vygotsky's theory to describe children's educational progression, it could also explain how adults learn and retain knowledge (Brandon & All, 2010; Fani & Ghaemi, 2011; Sanders & Welk, 2005).

By relying on the principles of sociocultural theory, education researchers advocate for a learner-centered approach, which reflects the students' knowledge and needs through the ZPD (Brandon & All, 2010; Phillips & Vinten, 2010; Rolloff, 2010). This approach could prepare students for life-long education and evidence-based practice, but it requires innovative teaching strategies to succeed (Phillips & Vinten, 2010; Rolloff, 2010). However, Daddow (2017) wrote that academic language may be challenging to understand, creating advantages for students from higher socio-economic backgrounds and disadvantages for those of underprivileged circumstances. Effective pedagogies, therefore, must adjust to improve an individual's knowledge and to target their ZPDs (Daddow, 2017).

The environment in which schools place students and where the students expect to learn socially can influence their ability to learn effectively (Kozulin, 2003). In the constructivist view, the environment refers to schemata and relationships that people perceive through personal experiences (Von Glasersfeld, 2005). Resnick's (1987) principles focus on the educator and the student and examined how educators use language as a cultural tool to mediate learning. Resnick considered the role of schooling in the preparation of individuals in terms of three broad areas: (a) participating in the economic society, (b) being a life-long learner concerning their work, and (c) participating in civic and cultural realms of society.

Resnick's (1987) work built on Vygotsky's (1978) central premise that social interaction is pivotal to how language and signs help socially construct knowledge. Vygotsky's seminal work, *Mind in Society,* introduced the sociocultural perspective, which focuses on how social factors, including language, culture, and people, impact the learning experience of the individual. Therefore, it is the communication between the learner and the advanced peer or educator that facilitates new knowledge for the student within the ZPD. As a result, learning occurs only when the learner can interact with the learning objects; namely, learners must have an opportunity to learn given their capabilities and learning potential within the environment (Gee, 2003). This theory provides further evidence that the environment can contribute to a student's SA.

Social interactions in the environment may also manifest through a student's fear of failure and judgment. When students have a fear of failure, they may be unable to perform to their fullest potential. This fear may lead them to drop out of the class or out of the program altogether, resulting in an increased attrition rate (Onwuegbuzie & Daley, 1999). Here, the definition of *attrition rate* is the measure of the individuals that move out of a collective group that share something in common (J. J. Walsh & Ugumba-Agwunobi, 2002).

In this problem of practice (POP) study, the commonality in the group is that they are nursing students taking the same course. As the fear of failure or other detrimental factors continues to impair the academic capacity of the student, the learner is likely to give up (Hjeltnes et al., 2015). Over time, many will drop out and opt for other careers, perhaps ones that they believe require less mathematics. While the reasons behind this attrition may be diverse, Kozulin (2003) posited that the ZPD in Vygotsky's (1978) social development theory aligns with the avoidance issues students face when anxious about a class. A student's inability to learn is a central contributor to nursing school attrition rates. However, the practice of useful educational approaches that promote self-efficacy and learning ability can reduce the difficulties that students face (Kozulin, 2003).

The nursing profession requires a wide array of practical skills along with theoretical knowledge; for this reason, nursing is an area in which educators need to implement a learner-centered approach to education. This literature review describes how educators can use the concepts of ZPD and scaffolding in the education of adult learners, and specifically for educating nursing students.

Applying the Zone of Proximal Development to Education for Adult Learners

The effectiveness of the university curriculum is the subject of several educational and psychological studies. In an interdisciplinary, qualitative focus group study that sampled 24 junior and senior-level preservice educators and preservice nurses from a college of professional education and a college of nursing in Texas, Dunlap et al. (2011) examined whether students acquired the competencies they needed to prepare for advanced coursework. The researchers gathered the data with a Metaplan focus group strategy in which participants expressed their ideas and opinions on a particular topic. During a group discussion, the researchers asked the participants to describe the skills they had attained during their studies, as well as which skills they still desired to acquire. Subsequently, Dunlap et al. held two separate focus group meetings: one for preservice educator participants and the other for preservice nursing students. Data analyses showed that while the students claimed that they had attained some of the competencies necessary for their future professions, they also expressed a desire for effective teaching strategies, more assignment variety, and additional practice-based learning opportunities. These competencies are crucial for students to perceive themselves as competent and successful.

According to Daddow (2017), students encounter many different social languages across casual, academic, and professional contexts. Students develop cross-disciplinary skills to make meaning out of the various languages students encounter in higher education. Therefore, Daddow (2017) conducted inaction research in an Australian university investigating the pedagogical possibilities that manifest when instructors implement student-adjusted and explicit literacies in the curriculum of two units of social work studies. Participants were students and their educators (n=153).

The researcher evaluated the educators' methods using interviews with students and educators, questionnaires, a student investigator's journal, and the analysis of course-related documents. Literacy practices that Daddow (2017) suggested included making *elite academic codes* explicit so that education was not exclusionary, which can change the discourse in education. Furthermore, she integrated social languages and literacies so that students could apply disciplinary knowledge across various contexts. In this case, she emphasized subject-specific learning to help students *code-switch* by communicating effectively across multiple social languages, including disciplinary, academic, and professional (Daddow, 2017).

Furthermore, she connected the pedagogy to students' lives through personal histories, community contexts, peer groups, and other networks of relationships to become student-adjusted. The results of Daddow's (2017) study indicated that when the pedagogy valued the literacy practices of the students, it resulted in decreased anxiety and increased dialogue and overall improved literacy levels in the students. What is more, these results highlight the connection to sociocultural theories of learning as well as integrate into Vygotsky's (1978) ZPD, which include the idea of scaffolding education through peer groups and educational discourse.

Researchers have also suggested ways that university professors can promote scaffolding in learning and facilitate students' internalization and implementation of new knowledge. Professors must act as role models for their students by providing adequate feedback and giving clear instructions, including notes, forms, videotapes, and use a variety of questions and concept maps to assess and assist the students (Sanders & Welk, 2005). In their theoretical paper, Fani and Ghaemi (2011) questioned the concept of the Zone of Proximal Teacher Development (ZPTD) and explained how Vygotsky`s (1978) ideas could serve to promote the education of teachers. The authors argued that the ZPTD ought to start with *self-scaffolding*, wherein educators reflect on their experiences before moving toward other forms of regulation.

Traditionally, researchers have thought that for the ZPD to emerge in an interaction, an educator must be dominant and demonstrate a higher level of knowledge than the learner. Havnes (2008) questioned the conventional understanding of the ZPD as he explored peer-mediated learning for students enrolled in philosophy and philosophy of science courses. By using a qualitative research design consisting of observation and unstructured interviews with the students, Havnes concluded that education expands beyond the traditional university curriculum. While learning together, students are involved in the process of finding meaning in the course content, the curricular requirements, and their student roles. Compared to educator-student learning, researchers found peer-mediated learning a more creative and intrinsically motivating method. It allows students to use different learning strategies, offers diverse solutions, and expresses conflicting opinions. As the students create this new learning context, their ZPDs emerge regardless of their competencies and hierarchical relationships.

Similar conclusions were drawn by Santora et al. (2013) in their qualitative exploration of mentoring of the participants in an international 5-year scientific and educational project in the U.S. and Norway. The researchers collected data via interviews and an online survey that the study's authors designed. The participants of the project (students and researchers) established multi-level mentoring, seeking out and receiving mentorship from nontraditional sources. They showed that mentoring had many benefits as it led to improved performance. Moreover, it helped the mentees' socialization into the culture of the workplace and the profession (Santora et al., 2013). These findings emphasize the importance of emotional factors in the learning process. Also, they relate to the present study since TBL is a form of mentorship between group members, where participants on the team can learn and guide simultaneously, as is also observed in mentoring relationships.

Additionally, Lapkin et al. (2010) described a case study where the ZPD emerged through conversations between a 71 year-old resident of a long-term care facility in Canada and a researcher. A qualitative examination of the conversation transcripts demonstrated that cognitive and affective components are required for the ZPD to emerge, which is mediated by language. This research provides further evidence of how using the ZPD can affect adult learners.

Applying the Zone of Proximal Development to Nursing Students

Over recent years, a constructivist paradigm has influenced theories on the education of nurses. Rolloff (2010) advocated for a constructivist approach to the education of nurses that begins in their junior year, which she claimed would prepare them adequately for evidence-based practice. Brandon and All (2010) highlighted the need for life-long education of nurses that implements constructivist theory and makes a shift toward a concept-based curricula. According to constructivist theory, learners should actively construct new ideas based on their previous knowledge. Therefore, the student and the educator should have an active dialogue between them, and the educators should make efforts to create the ZPD in the interactions.

A pilot study by Phillips and Vinten (2010) evaluated nurse educators' intent to adopt innovative teaching strategies that embrace the principles of Vygotsky's (1978) theory in clinical nursing education. The quantitative sample consisted of 71 nursing educators who had completed an online course offered by the Indiana University School of Nursing and the National League for Nursing. After completing the online course, the researchers asked the participants to complete a survey the authors had designed. They intended this survey to evaluate the use of innovative teaching strategies. The qualitative sample consisted of 46 clinical nursing educators whom the researchers asked about innovative teaching strategies that they intended to explore in the future. Accordingly, the analysis of the responses demonstrated that the role of clinical instruction was changing, with a greater emphasis now on facilitating the process of learning by adjusting teaching strategies to the needs of students and encouraging them to apply new knowledge (Phillips & Vinten, 2010).

In their investigation, Rhodes et al. (2012) applied a learner-centered approach at the Auburn Montgomery School of Nursing with their undergraduate nursing students to find ways that clinical instruction was changing. They conducted a 4-hour seminar structured around Miller's Wheel of Professionalism in Nursing (Miller, 1984). The seminar provided new and advanced students with the opportunity to interact with each other in small-group discussions while the faculty facilitated the discussion concepts to promote higher-level learning. The researchers presented various problem-based situations to the students and discussed various possible solutions. Each situation reflected a different aspect of professionalism in nursing. The authors claimed that this seminar was useful to develop professional nursing skills as well as for socializing new students.

Some researchers have emphasized the need for modern, flexible teaching strategies in nursing education (Day-Black et al., 2015; Kiegaldie & White, 2006). In 2006, Kiegaldie and White analyzed the use of a *virtual patient* at Monash University's School of Nursing in Australia. A virtual patient is a multimedia learning resource that offers students the prospect of active learning, testing their knowledge, and discussing and constructing ways of understanding the content. Twenty-four students completed the questionnaire, while the researchers conducted two focus group interviews to evaluate the use of a virtual patient.

In a more recent study, Day-Black et al. (2015) explained how educators could use gaming to facilitate the process of active learning for nursing students by making a creative, student-centered, and safe environment. The researchers implemented two *serious games*, which are games used for purposes other than mere entertainment, in the curriculum of the Mid-Atlantic HBCU School of Nursing in Maryland. The games aimed to develop the students' problem-solving skills and knowledge of public health and epidemiology. The course sampled 42 traditional students and 45 nursing students, and the researchers used a reflective assessment form of metacognition after gaming to provide feedback. The results of these studies showed that serious gaming increased students' motivation for learning, critical thinking, and the use of metacognitive strategies in learning. The authors stated, "the progression of learning that occurs over time during games is similar to the effect of 'scaffolding,' which builds on the concept of the ZPD" (p. 91). However, students and educators need to understand the purpose of multimedia resources to enable a deeper understanding of the material (Kiegaldie & White, 2006). Together, these studies provide evidence of how educators can use TBL to help nursing students scaffold learning through the ZPD.

Nurses and caregivers can use the concept of the ZPD, not only to facilitate the learning process of an individual, but also to enhance the wellbeing of the whole family. By analyzing health policy in Australia, Hopwood (2015) explained that caregivers could apply Vygotsky's (1978) theory to improve the quality of the care model due to partnership and support for families facing difficulties in raising their children. The partnership model is challenging for families and caregivers, but caregivers can help the family solve this problem through the mediation of tools and signs to help the family move through their ZPD. The results from Hopwood's (2015) study describe how to use ZPD in clinical nursing practice.

Overall, educators can apply the principles of sociocultural theory to facilitate the learning process (Daddow, 2017; Havnes, 2008; Phillips & Vinten, 2010). In particular, nursing educators should embrace innovative teaching methods and a learner-centered approach to prepare their students for this challenging profession (Rhodes et al., 2012; Rolloff, 2010). Additionally, students should have an opportunity to practice active communication skills with their educators and their peers in an environment where they can share without fear of judgment and can receive adequate feedback (Day-Black et al., 2015).

Furthermore, improvements in technology have expanded the possibilities for successful practices, promoting scaffolding (Day-Black et al., 2015; Kiegaldie & White, 2006). Educators must not be just knowledge transporters, but active creators of an environment that functions in the service of their students. Educators must also accept the role of a scientist, using the methods of qualitative, descriptive, and action-based research to explore learning possibilities for their students and themselves.

Intervention Literature Review

This literature review provides information on interventions that educators may use to address SA and SSE in undergraduate nursing students. This review considers the individual and instructional level interventions applied in statistics and research courses in nursing and health science programs. The student investigator performed a search of the relevant literature from January through March 2017. She repeated the search in September 2018 using the following databases: EBSCOHost, ERIC, PubMed, and Proquest. She used search terms that included *interventions, statistics anxiety, statistics self-efficacy, nursing*, *undergraduate*, *university*, and *college* (including title, abstract, keywords, and full text), as well as all study types in peer-reviewed journals.

Individual Level Interventions

Value Reappraisal

Some interventions improve student self-efficacy levels from an individual-based perspective. *Value reappraisal* is the perceived value, or worth that a student places on a subject. It is a topic that researchers have studied even more copiously then mathematics anxiety (Carey et al., 2016; Kyttälä & Björn, 2010; Peixoto et al., 2017). While educators have used this technique successfully in other subjects, only one article exists that examined value reappraisal for reducing SA in college students.

According to Acee and Weinstein (2010), educators can use the value reappraisal technique to induce a student's attitude to change in a positive direction and aid in reducing SA at the individual-level. Value-appraisal strategies include imagining, brainstorming, contrasting the pros and cons, and generating rationales that increase the value-perceptions of students. The researchers conducted a randomized study investigating the effects of value reappraisal on SSE and choice behavior among statistics students. Their goal was to help students reappraise positively the value that they placed on developing and utilizing statistical knowledge and skills.

The researchers conducted the study at a large public university in the South Central U.S. It comprised of 82 undergraduate students and two instructors in an introductory statistics course during the Fall and Spring semesters: 41 students were in the treatment group and 41 students were in the control group. In the treatment group, Acee and Weinstein (2010) presented the students with messages on the importance of understanding statistics in everyday life, academic and professional uses of statistics, and intrinsic enjoyment in learning statistics. After that, the students responded to questionnaires related to task value and self-efficacy at four points throughout the semester. Overall, the results of the study revealed that value reappraisal had positive effects on students' choice behavior and class performance. It showed that the value reappraisal of students' learning is one way that educators can reduce students' SA. As a result of value reappraisal, the students became self-motivated and engaged in learning events that the instructors geared toward statistics. Eventually, the value reappraisal resulted in improved performance, helping students increase their value perception (Acee & Weinstein, 2010). It also may have increased their level of interest in the subject and their future performance. These results indicate that utilizing value reappraisal techniques can effectively reduce SA.

Positive Peer Role Models

As in the case with value reappraisal, using positive peer role models to provide a vicarious experience is a topic that researchers have studied a great deal in other subjects. However, there is only one article that examines the impact of vicarious experiences on SA in college students. That study by Bartsch et al., (2012), sampled 39 graduate students enrolled in a statistics and research methods course. They aimed to determine the impact of using a *vicarious experience* in reducing SA. A vicarious experience involves former students coming to a class they had previously taken to explain their academic histories and provide insight into the behaviors that led to their success in the academic course. This experience served as a peer model for the students enrolled in the course.

In the study conducted by Bartsch et al. (2012), the students first completed a self-efficacy survey during the first 2 weeks of the course. Then 2 weeks later, the researchers assigned the students to either a control group or an experimental group. The researchers asked the participants in the control group to imagine how a successful student would perform in statistics. They introduced participants in the experimental group to a former student who came to class to talk about how she had overcome SA. Bartsch et al. analyzed the data using a 2x2 factorial Analysis of Variance (ANOVA) design; they investigated how self-efficacy changed based on testing time (pre-test/post-test) and group (control/intervention). The results of the study indicated that the vicarious experience that the peer mentor provided resulted in a significant increase of SSE compared to the students in the control group. Therefore, providing a vicarious experience using a student model can be effective in increasing SSE and decreasing SA.

Religious Motivation

Religious motivation may be another way to reduce SA among college students by improving relationships between the instructor and the student. Evidence for religious motivation's effectiveness in reducing SA was investigated in Mvududu and Larocque's (2008) study that examined the relationship between faith, hope, and SA. Researchers in this study sampled 70 undergraduate students, 23 from a Southeast U.S. secular university and 47 from a Northwest U.S. Christian university. All participants in the study were health science and education majors enrolled in an introductory statistics course. The researchers collected the data using surveys where students self-reported attitudes toward statistics, dispositional hope, anxiety levels, and religious motivation. Overall, the results of this study indicated that religious motivation significantly correlates with SA. Students from the Christian university had an intrinsic religious motivation, positive attitude, hope, and less SA compared to those from the secular university. Consequently, the researchers concluded that religious motivation could reduce SA levels. Therefore, integrating religious motivation strategies in statistics education could reduce student SA levels.

Additionally, hope may influence anxiety about statistics because statistics is such a difficult subject for many students (Onwuegbuzie, 1998). The author Onwuegbuzie (1998) posited that two elements of hope could explain how individuals pursue goals—agency (perception of a strong ability to meet goals in the past, present, and future) and pathways (perception of successful strategies to meet goals). The researcher conducted a quasi-experimental study using a sample of 109 students enrolled in a statistics and educational research methods course. Each of the students volunteered to take a survey consisting of two instruments, one assessing hope and the other assessing SA. The results indicated that students with low levels of hope—demonstrating insufficient agency and pathways—exhibited higher levels of SA. Therefore, Onwuegbuzie suggested that interventions should focus on agencies and pathways to reduce SA. These results and conclusions tie into the research Mvududu and Larocque (2008) conducted where they found that hope was related to anxiety as well as religious motivation. Consequently, faith integration may be a helpful way to improve hope and decrease SA since students with low levels of hope and high levels of SA are likely to avoid statistics as long as possible, thinking that the material is irrelevant to their academic and professional goals (Onwuegbuzie, 1998).

Students tend to regard technical courses like research and statistics as more difficult and less relevant to their personal lives and careers compared to other courses (Poelstra, 2009). In research that Poelstra (2009) conducted, he described *faith-praxis* integration as a relational construct involving faculty who impact the spiritual lives of their students. Educators can apply faith-praxis activities by providing opportunities for spiritual growth through value and character development. Ideas for how to incorporate this development into course content include investigator bias, honesty in results reporting, and faculty-student interactions. Statistics courses can be frustrating, and students will sometimes superimpose that frustration onto the educator (Poelstra, 2009). The emphasis placed on developing relationships with students to help them feel safe may be a way to harmonize faith with life to decrease student anxiety levels. Therefore, these religious motivation and faith-praxis activities that highlight the importance of student and teacher communication and interaction may share constructs with those ideas discussed in the instructor's immediacy section. As a result, individual-level interventions emphasize relationships, communication, and trust.

Instructional Level Interventions

Feedback

Often, SSE has often been mentioned in relation to students' SA (McGrath et al., 2015). McGrath et al. (2015) surveyed 28 students in an advanced psychology class using an 18-item Statistical Anxiety Rating Scale (STARS) instrument to measure their SA. The students were given the same test toward the completion of the semester. The instructor used the test as an opportunity to guide the students by assigning a paper, writing remarks, and then allowing students to redo the paper so as to learn from their mistakes. After the test, students pointed out that instruments like how-to guides ensured they were always aware of the topics that would be covered. Consequently, this activity enhanced the clarity of the topic they were studying. When the instructor used these strategies with tests, they could guide the students in the direction required for the research study. McGrath et al. (2015) found that this change in pedagogy decreased anxiety and increased self-efficacy for the students in the statistics course. These results are in alignment with Vygotsky's (1978) conception of the ZPD, as the educator can push the students to learn a little more than they would have taught themselves.

In the study conducted by McGrath et al. (2015), they determined that one way of increasing SSE was through subjective methods of marking examinations. They used the grade a student earned on a test as a measurement of performance in the class. Students experienced increased pressure to perform better, which then increased the students' fear of examinations. Participants were afraid of failing and of performing more poorly than their colleagues. Accordingly, participants in the study proposed that, instead of using grades, instructors should embrace qualitative assessments that allowed students to redo their exams (McGrath et al., 2015).

Furthermore, there was overwhelming support for using assignments to help the students gain knowledge as opposed to taking tests. The use of assignments in class allowed the students to carry out extensive research, which increased their level of understanding and built on their skills (McGrath et al., 2015). In this study, McGrath et al. (2015) urged the instructors to ensure that when introducing new material, they were clear about how the material applied to statistics and in real life.

While McGrath et al. (2015) found that qualitative feedback improved student self-efficacy levels, Hall and Vance (2010) found that the use of positive and negative feedback improves SSE. The participants in their study included 138 students, each of whom were majoring in either business, health, or the sciences. They assigned the participants randomly to the feedback or no-feedback groups and then gave them a three-question test. They repeated the same test after they gave the participants the answers. The researchers used real-time evaluation and progress indicators to show the students the results of their efforts. Consequently, providing immediate feedback to the students resulted in a significant improvement to SSE (Hall & Vance, 2010).

In the study, Hall and Vance (2010) showed that placing the control group in an environment where educators supplied constant feedback helped the students to perform significantly better than students in the traditional classroom who did not receive immediate feedback. As the students collaborated in solving statistical problems, they decreased their SA as reflected by an improvement in their testing performance (Hall & Vance, 2010). These results align with those identified by McGrath et al. (2015), showing that instructor feedback can decrease SA levels and improve SSE. Therefore, whether in the classroom or outside the class environment, conditions conducive to constant feedback must be created.

The use of feedback supports social cognitive theory, predicting that feedback increases students' level of self-efficacy (Bandura, 1986; Bransford et al., 2000). As a result, there is a need for the instructor to give consistent feedback on students' performance; hence, real-time evaluation and progress indicators result in an improvement in students' efforts. Providing feedback may decrease student anxiety and improve academic performance (Hall & Vance, 2010; McGrath et al., 2015).

Increasing Lecturer Immediacy

Another way of considering the effect of instructor feedback is to look at how increasing lecturer immediacy impacts student self-efficacy levels. *Immediacy* refers to a set of communicative behaviors that increase the perception of physical and psychological closeness (A. S. Williams, 2010). People tend to approach things that provide them with pleasure while avoiding those that lead to pain or fear. In alignment with Bandura's (1986) social cognitive theory, the more a situation is pleasurable, the more it appears favorable; therefore, when educators practice immediacy, they are considered exceptionally welcoming and available by their students. The verbal and non-verbal actions of their instructors influence students' academic behaviors. According to A. S. Williams (2010), these actions include praise, humor, personal disclosure, and engaging in conversation.

Using 76 graduate students enrolled in an introductory statistics course in the college of education at a large Southwestern university, A. S. Williams (2010) designed a control group to assess the effects of instructor immediacy on SA. The participants came from a variety of disciplines, including nursing, education, sports science, forensic science, and communications. A. S. Williams taught two sections of the course using an intervention group where students received instructor behaviors that reflected immediacy and psychological availability. Adjunct instructors taught two additional sections of the course, which served as the control groups. In the pre-test, the students took the STARS to obtain a baseline level of SA. Then, in the post-test, the students again took the STARS, this time to assess SA through its subscales: (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, (f) and fear of statistics teachers.

Additionally, in the post-test, A. S. Williams (2010) measured instructor immediacy using the Instructor Immediacy Scale. The results of the study indicated that instructor immediacy was statistically significantly associated with the six subscales of the STARS.

Furthermore, instructor immediacy explained between 6% to 20% of the variance in students' levels of SA. Therefore, applying techniques that relate to instructor immediacy such as engaging in behaviors—including smiling, using eye contact, and being verbally expressive—teachers may help decrease SA levels in graduate students in various disciplines.

Several advantages can increase educator immediacy. First, according to Ruggeri, Diaz et al. (2008), poor communication is a significant reason for SA. They discovered the relationship between educator immediacy and SA after administering a Composite Study of Statistics Anxiety and Attitudes (COSSAA) test with 463 participants in universities in Spain, the U.S., Austria, and the U.K. The COSSAA is a combination made from SATS and the STARS. The original language of each of these instruments was in English, but they translated them into Spanish and German so that the students could take the surveys in their native languages. All participants were undergraduate students enrolled in an introductory psychology statistics course. Ruggeri, Diaz et al. administered the COSSAA to students at different points in their education based on their language.

The results showed that educator immediacy played a significant part in reducing student anxiety. Overall, results that Ruggeri, Diaz et al. (2008) obtained showed that the teachers' influence significantly correlated with the statistics subscales. While these results assess instructor immediacy and SA, the same constructs that A. S. Williams (2010) used varied widely by the methodology and participants. The participants in the study A. S. Williams conducted were graduate students from different disciplines at the same university who took the SA and instructor immediacy instruments at the same point in the semester. In the Ruggeri, Diaz et al. study, the participants were undergraduate psychology students from different universities and four different countries. They gave the assessments at different points in the semester and different languages. Although the methods and participants varied between these two studies, the results were consistent and suggest that instructor immediacy may be an effective way to decrease SA in students in different contexts. Through educator immediacy, the students relayed their most significant questions to educators, improving student-educator communication.

Another form of educator immediacy is the one-minute paper strategy. In a study of 77 undergraduate sophomore students in Taiwan, Chiou et al. (2014) used a quasi-experimental pre-test/post-test group design. The researchers gave the students one minute after every statistics class to answer questions concerning the most significant concept they learned that day and to write down any questions the instructor had not answered. Then, the students gave the handwritten papers to the instructor. In the subsequent class, the educator responded to the questions and provided quick and substantial feedback. Responding to the students' questions improved the feeling of educator immediacy and allowed the educator to provide useful feedback without necessarily pointing out the students who asked the questions. This strategy improved the student-educator interaction, positively impacting the performance of students (Chiou et al., 2014).

Like A. S. Williams (2010) and Ruggeri, Diaz et al. (2008), Chiou et al. (2014) used the STARS to assess SA levels in their participants. The results of this study indicated that by introducing learning strategies that encourage immediacy, 20% of the fear students had toward statistics educators was eliminated. By using the one-minute paper strategy, instructor immediacy occurred as student-teacher interactions improved, creating a classroom climate with increased harmony and understanding. The one-minute strategy approach also empowered the students as they critically reflected, which encouraged self-learning (Chiou et al., 2014). Therefore, through the use of the one-minute paper strategy, learning improved, and student anxiety decreased.

As Ruggeri et al. (2008) cited, increased communication between teachers and students is a critical component in instructor immediacy that results in a decrease in SA. The one-minute paper strategy that Chiou et al. (2014) shared may function in the same way. The student-centered feedback activates interaction and communication between students and the teacher, ultimately enhancing effectiveness and decreasing distress. As a result, A. S. Williams (2010), Ruggeri et al., and Chiou et al. emphasized the importance of immediate feedback and unambiguous, open communication within the classroom.

Increasing lecturer immediacy addresses the need to reduce student-educator anxiety (A. S. Williams, 2010). With increased immediacy, students view their education as a collaborative effort with the instructor (Ruggeri et al., 2008). The educator creates a relationship, reducing the gap between educator and student by providing constant feedback (Ruggeri et al., 2008; A. S. Williams, 2010). Unlike web-based instruction, instructors use this method best in a face-to-face classroom environment because it relies on verbal and non-verbal cues (A. S. Williams, 2010). Moreover, the answers provided by the educator immediately increase the confidence of students (Chiou et al., 2014).

Instructional Strategies for a Positive Emotional Climate

Using Humor in the Classroom. *Humor* refers to the ability to introduce amusing concepts when teaching statistics. Schools expect students who major in health-based programs to enroll in statistics courses as part of the required curriculum, which may come as an unwelcome surprise to the students. Because the students consider these classes less critical for their careers, they lose motivation and concentration leading to SA, especially during exams (Field, 2009). However, educators' use of humor in teaching these courses has shown to increase students' concentration levels, ultimately reducing SA.

One way of introducing humor into statistical classes is to identify real-life examples of critical theoretical questions using unusual methods. Field (2009) explained that students lack the motivation for learning statistics. This can cause SA, leading to a lower course performance. As a result, Field suggested using humor from real-world examples to help decrease anxiety, increase motivation, and make learning stay fresh. In his article about using humor to make psychology students learn to love statistics, Field made one specific suggestion for a real life example that his students found interesting and humorous.

That study was conducted by Miller et al. (2007) in Albuquerque, New Mexico. Using 18 lap dancers and data from their 296 shifts and about 5300 lap dances, the researchers tested an evolutionary theory: He tried to prove—incorrectly—the hidden estrus theory, which is that men find women most attractive when they are in their fertile menstrual cycle phase. The researchers collected data on the amount of money lap dancers received during different stages of their menstrual cycle. The data from this study was interesting, attention-grabbing, and memorable for students. Field (2009) suggested using this type of example as a way to address the creation of a research question and conduct and analyze a study. Based on this example, it seems possible that finding and using unusual, humorous cases could increase the concentration of students in statistics classes.

In another study on the use of humor to decrease SA, A. S. Williams (2010) carried out a pre-test/post-test analysis on a group of 76 graduate students from a large Southwestern university to determine the qualities that reduced their SA. In classes where lecturers used humor as one of the teaching elements, the students were less anxious about statistical topics and performed better than the class average. Furthermore, A. S. Williams (2013) referred to the work of Schact and Stewart (1990) on the benefits of using humorous cartoons in teaching statistics. Their research showed that when the instructor used a cartoon of a man chasing runaway pets as fictitious data to calculate probability, it reduced students' anxiety and increased their learning.

Humor may also increase the level of attention, resulting in improved learning (Epting et al., 2004). In a survey of 119 undergraduate students in their junior and senior year from a large Southern university, Epting et al. (2004) asked students describe their ideal college professor and then compare that to the experiences they had with the typical college professor. The researchers procured data using a quantitative survey consisting of 40 multiple-choice items, assessing personal factors, course design and policies, and classroom behaviors to determine the essential qualities of an excellent educator. The results indicated that students preferred educators who used humor occasionally. They identified the ideal educators as those who provide humor when teaching and use humor to explain certain concepts.

The use of humor is encouraged in face-to-face and online teaching methods. In DeCesare's (2007). study of 196 sociology students at a California university, the researcher found that the use of humor played a critical role in further understanding the statistics used in the coursework. DeCesare used a seven-part questionnaire administered to assess and quantify the extent and causes of SA. Because of the concern that non-statistics majors might lack motivation, DeCesare asserted that the use of humor might help motivate students' attention to the curriculum and engaging in class. Further, DeCesare found that the use of humor helped students become less fearful of instructors, which may also be a contributing factor related to higher levels of SA.

Instructors can infuse humor into the curriculum in a variety of ways. In a study by Ford et al. (2012), the researchers sampled 84 participants from a public university in North Carolina and divided them into three groups to investigate the benefits of humor in reducing SA. The researchers used a pre-test/post-test method to show that when the instructor exposed the treatment group to funny cartoons during teaching, they performed better than the groups that teachers exposed to non-humorous poems or nothing at all.

However, not all humor is suitable for statistics classes. When the instructor did not customize the humor to fit the topic of discussion or did not relate the humor to statistics, the students judged it as a waste of time (Ford et al., 2012). Moreover, the students' anxiety levels may have potentially increased during exams. In concordance with these results, McGrath et al. (2015) found that humor was only useful for those who had a negative attitude toward statistics, but it was a distraction for those who already viewed the statistical content positively. Therefore, while humor may improve learning, attention, and retention for some students, it may not be a useful intervention for all students.

Online Learning. Online learning using web-based instruction may impact student self-efficacy levels. *Web-based instruction* involves the use of distance learning tools that connect students and the instructor through technology. A qualitative study conducted by Van Gundy et al. (2006) assessed the impact of using a *digital dropbox*, which provides electronic access to class materials and students' discussion boards to investigate the relationship between student self-esteem, sense of mastery, mathematics anxiety, and web-based instruction. The authors distributed tests to 175 undergraduate statistics students at a predominantly White university in the Northeast U.S. They subjected the students to three study conditions, each condition with different levels of access to the internet and other web-based services.

The instrument Van Gundy et al. (2006) used included seven questions related to the sense of mastery, six questions to assess self-esteem, and a ten-item version of the SMAS to determine mathematics anxiety. The results indicated that at the beginning and the end of the study, students exposed to web-based instruction performed better than their counterparts who were without exposure. Overall, Van Gundy et al. (2006) found that using web-based instructional design reduced mathematics anxiety.

In another study on web-based instruction in statistics, Güzeller and Akin (2012) took 62 sixth-grade mathematics students at a public elementary school in Turkey and divided them into two control groups. The first 12 students had access to a computer and the internet, while the other 50 students did not. The researchers used the Mathematics Attitude Scale, the Mathematics Anxiety Scale, and the Mathematics Self-Efficacy Scale. Using a pre-test/post-test methodology, the authors applied a Mann-Whitney U test to identify the performance changes of the students at the end of the semester. Academic achievement was measured using the Mathematics Achievement Test developed by the authors. Because most of the students with access to the computer performed better than those without, it appears that web-based instruction can reduce SA. Therefore, these studies demonstrate that web-based instruction has a positive impact on student performance in statistics (Güzeller & Akin, 2012; Van Gundy et al., 2006).

Web-based instruction has several advantages. One significant advantage is that because the tools are asynchronous, educators can achieve student-centered learning across space and time (Güzeller & Akin, 2012; Van Gundy et al., 2006;). The students are in a position to access the course material on their time and in the most convenient place for them. Additionally, using online material for teaching enhances collaborative learning among students.

As a result, online materials combined with collaboration among students can reduce the students' fear of statistics educators, which is one of the predominant factors associated with SA. Similarly, students who avoid participating in discussions in the classroom environment get an opportunity to ask questions in a less restrictive environment. However, web-based learning is resource-intensive and may not be possible in specific environments or for certain populations, including adult students who may not be comfortable using technology for education. Furthermore, students may be inactive in online and offline lessons. Web-based instruction for students in college and even those engaging in distance learning is useful, but some limitations accompany the use of educational technology.

Team-Based Learning. The following provides a review of the current pedagogy, education, and research demonstrating some of the advantages of TBL compared to the current traditional teaching methods, emphasizing an individualistic form of education (Kilner & Sheppard, 2010). Overall, TBL is useful in redefining instruction, teaching, and learning processes, as well as education in general, in the field of nursing. Education using TBL may be especially useful in nursing education because of the high level of socialization required in the clinical nursing career. As a result, TBL instructional methods have the potential to improve patient safety and reduce clinical errors in clinical nursing practice (Kilner & Sheppard, 2010).

Interventions using TBL not only improve effectiveness, but also foster student engagement and participation through small group work, which promotes a positive attitude toward learning (D'Souza et al., 2013). Furthermore, the formation of small learning groups like those used in TBL increase the subject's perceived value among students, encouraging engagement, participation, and divergent learning (D'Souza et al., 2013).

The traditional method of instruction has continued to make learning quite problematic for many students enrolled in university nursing programs, and it also creates challenges for practicing nurses (Blouin et al., 2009). The current educational standards prioritize the recollection of knowledge, but pay very little attention to the students' ability to interpret, understand, and apply this knowledge (Blouin et al., 2009).

According to Blouin et al. (2009), the current system and approach toward education have transformed class from a place of learning and understanding to a place of transmission of facts to students. As a result, Blouin et al. posited that this approach is detrimental to the actual education of students and argued that class time should not be purely for said transmission of facts. Instead, it should include discussions and activities among students or between students and the faculty as a way to nurture understanding and critical thinking abilities. Furthermore, Blouin et al. asserted that adoption of evidence-based education is critical to overcoming the challenges posed by the traditional methods of instruction. With evidence-based education, objective, scientific research informs decision-making processes. Therefore, educators can emphasize critical thinking skills, and evidence would come primarily from academic peer-reviewed research, scientific findings, and data.

This point of view was shared by Anderson and Thorpe (2014), who advocated for the need to educate students better through avenues such as facilitating contributions (positive and critical) to the course material they studied. In their research, the authors observed 23 staff members from six different primary health care teams facilitated by eight different instructors. The staff and instructors effectively improved value in the student work. Moreover, patients noted benefits that were directly attributed to student work, signifying the importance of inter-professional TBL (Anderson & Thorpe, 2014). Therefore, TBL may be a useful learning technique in nursing education.

Many adult nursing students often experience fear of failure because they are unable to understand and internalize the information they learn in class (Hjeltnes et al., 2015). This inability results in high levels of anxiety, frustration, and even attrition. In an assessment of the experiences of 29 university students who completed an 8-week mindfulness program aimed at evaluating academic anxiety, Hjeltnes et al. (2015) learned several valuable lessons. They found that mindfulness helped students alleviate academic stress and overcome their fears of failure. Moreover, they observed that the students gained inner sources of calm, greater self-acceptance, and overcame fears. Finally, they observed that the students developed a curiosity in their academic learning, stayed focused during learning, and shared a universal human struggle (Hjeltnes et al., 2015). Therefore, the use of TBL interventions has the potential to completely change the way adult nursing students respond to academically challenging conditions.

In-Class Collaboration. In the literature, authors sometimes **use** the terms *collaboration* and *collaborative learning*, denoting group work, discussions, and shared community. Within the literature review, these concepts are situated within the broader context of TBL as they share many of the same principles and practices.

In-class collaborative efforts can also change the pedagogy of teaching and are capable of creating systematic change to the climate of teaching statistics. The recommendations of the 2007 American Sociological Association teaching conference highlighted several strategies that can reduce students' anxieties through a collaborative classroom environment. Forty sociologists gathered to discuss best practices. Workshop facilitator's, Macheski et al. (2008), explained strategies at a forum entitled *Innovative Teaching Practices for Difficult Subjects.* They asked participants to consider "building a community of learners" in statistics, research methods, and theory courses (p. 42). Conference attendees discussed the process of building a collaborative learning environment that requires instructors to create and maintain an active role for students, a common language of discourse, and a supportive emotional environment (Macheski et al., 2008).

Accordingly, their ideas support the research that these learning factors could enhance students' engagement and reduce SA.

As a result the discussion, Macheski et al. (2008) identified two ways to achieve a new climate and teaching system. First, they suggested creating a new first-day experience for students, focusing on ensuring that students build a relationship on the first day of class rather than teaching course content. This practice is in alignment with the strategy Pan and Tang (2004) utilized by beginning the statistics course with an orientation, effectively reducing SA in the process. The first-day experience makes classroom activities more interactive and creates an environment where the people feel emotionally safe.

The second step was to ensure ongoing community-building processes (Macheski et al., 2008). In this case, Macheski et al. (2008) suggested giving students an active role in an emotionally supportive environment because an environment with disengaged students and teachers is one of the main problems for students when learning statistics. When interactions with educators do not go beyond asking questions, student anxiety increases and student interest in learning statistics decreases. This experience indicates that by creating a community in class, educators may effectively decrease SA.

Researchers studied in-class collaborative problem-solving as a way of reducing SA among college students. One such case study was Kinkead et al.'s research (2016), where they investigated adult perceptions of an intervention. Based on the results of this study, the majority of participants considered in-class collaborative problem-solving a helpful strategy for mitigating SA. Of the 14 participants, ten (71%) considered this approach helpful, compared to four (29%) who perceived in-class collaborative problem-solving marginal or problematic. However, partner compatibility influenced many of those who did not consider in-class collaborative problem-solving helpful in reducing SA. These findings introduce further research on the effect of in-class collaborative problem-solving in reducing SA.

Institutional Implementation. Although innovative learning practices, such as TBL, may be identified as a best practice, it can be challenging to implement due to the educational infrastructure. A core problem with the pedagogical deficiencies experienced today lies within the educational system and its institutions (Anderson & Thorpe, 2014; Blouin et al., 2009). According to Boet et al. (2014), the answer to this pedagogical problem for implementing innovative learning practices is situated in changing the approach and interventions taken toward education. In their study, Boet et al. described twelve tips that are core to achieving a successful interprofessional team-based simulation session among students. The authors suggested the use of TBL approaches, especially those that also incorporate simulation-based learning interventions instead of the previous individualistic interventions that educators usually apply.

There is an unlimited need for students trained in nursing to become experts in their field. However, Boet et al. (2014) stated that TBL interventions that also incorporate simulation-based learning must replace the current approaches and interventions. It is through this route that institutions can facilitate authentic learning (Boet et al., 2014). As a result, the adoption of TBL practices may improve education outcomes at an individual-level through team-based simulation activities. However, the university infrastructure must be in place and accommodate these practices for success.

Team-based simulation may be a valuable way to improve student learning and confidence in nursing education. *Fidelit*y is the "believability of realism of a simulation scenario and includes the physical, psychological, and social aspects of simulation" (Najjar et al., 2015, p. 30). In their study of three student cohorts enrolled in a baccalaureate nursing program, Najjar et al. (2015) found that *high-fidelity simulation* in groups (e.g., realism of mannequins and actors, equipment and supplies, the scenario itself, and interaction with the faculty) significantly improved students' multi-dimensional experiences in learning, making them better equipped and more confident.

Through a qualitative, grounded theory research design, Najjar et al. (2015) conducted focus group interviews with 26 students. Five dominant themes emerged: (a) emotional processing, (b) anxiety, (c) making connections, (d) fidelity, and (e) learning. They found that student anxiety levels were so high initially that they inhibited cognitive processing; however, after the students completed the simulation exercises in groups, anxiety levels decreased. These results suggest that student confidence improves when the social process of simulation through peer-to-peer interaction enhances the learning experience (Najjar et al., 2015). Together with the results obtained by Boet et al. (2014), these studies highlight the importance of high-fidelity simulation in improving technical skills, clinical judgment, knowledge, and self-efficacy among nurses through the use of a TBL intervention.

More evidence of the use of TBL was presented by Clark et al. (2008), who indicated that for students to learn and be genuinely educated, they must not only engage in the work they do, but the TBL interventions must have a high rate of effectiveness. In Clark et al.'s TBL intervention study, there were 70 junior nursing students enrolled in one of two classes: one where instructors taught students in a traditional lecture-based environment, and the other where educators taught students using a TBL curriculum. They measured student engagement using an eight-item Likert-type scale called the Classroom Engagement Survey.

It was suggested by Clark et al. (2008) that a sizeable student-faculty ratio is a barrier to successful education. In their study, Clark et al. established that small, independent groups can achieve successful learning in high student-faculty ratios of up to 200:1. Additionally, they noted that educators could achieve the effect of TBL ratios without losing any benefits that are inherent in groups with ratios of approximately 7:1. The results of their study indicate that in comparison to traditional lecture-based teaching methods, TBL instruction is more effective for classes that have a high student-faculty ratio. At present, many institutions struggle to achieve a favorable student-faculty ratio. Therefore, traditional education methods that use lectures and individualistic assessments primarily continue to limit educational effectiveness (Clark et al., 2008). As a result, higher than the recommended student to faculty ratios may limit institutions' abilities to offer the TBL curriculum.

Institutional-based outcomes may be an excellent way to provide student support. Intervention changes that focus on curriculum and pedagogy may support students in ways that other individualistic interventions cannot (Clark et al., 2008). In nursing education, team-based simulation activities can achieve this support (Boet et al., 2014; Najjar et al., 2015). Therefore, incorporating aspects of TBL may improve educational effectiveness and decrease student anxiety levels.

Team-Based Learning in Nursing. Many of the benefits of TBL may apply to other educational fields as well. However, the nursing population has experienced a higher level of attrition and anxiety compared to other fields (Deary et al., 2003). Moreover, the ineffective teaching interventions of colleges and universities may have partially caused this attrition (Donahue, & Thiede, 2008). Therefore, TBL may be especially useful at mediating anxiety and self-efficacy in nursing education.

In addition to the research presented about the benefits of TBL interventions in nursing education, Ofstad and Brunner (2013) suggested that TBL initiatives improve communication and academic performance among nursing students. The authors arrived at this conclusion through critical observation and discussion of literature reports they obtained from Pharmacy, Nursing, and Medical programs. Because TBL requires students to read ahead and prepare for the upcoming class, students must meet with their teams to prepare, which further increases student engagement with each other and with faculty (Ofstad &

Brunner, 2013). The results of this study suggest that increasing student engagement may decrease SA in health science students.

According to Sharkey and Sharples (2003), work-related stress partially influences fear of failure. In their study, they created TBL projects to help manage stress among various groups of students. They recruited 41 participants who were either nurses, psychiatrists, occupational therapists, psychologists, or social workers in acute inpatient and community care facilities within a large rural setting. Using data from these health care workers, Sharkey and Sharples measured work-related stress using the Occupational Stress Indicator (Cooper et al., 1988) and the Healthcare-Related Work Pressure Scale they adapted from the Nurse Stress Index (P. E. Harris, 1989).

In this quasi-experimental study, the researchers used a pre-test/post-test methodology to measure data 8 weeks before and 8 weeks after the intervention. The results indicated that TBL projects were successful in managing work-related stress among the participants, highlighting the effectiveness of TBL in managing clinical risk. Moreover, these results provide support for the notion that the TBL skills that nursing students learn in the classroom could translate into useful skills for clinical practice. This outcome is consistent with the results obtained by Najjar et al. (2015), which identified that peer-to-peer connections decrease student anxiety in clinical nursing practice.

Furthermore, Seymour (2013) highlighted the importance of problem-based TBL interventions for managing adult nursing student anxiety by assessing how TBL in education increases clinical effectiveness. In an ethnographic study conducted in the U.K., the author interviewed 61 community nurses and ten adult nursing students to understand how problem-based learning influenced the development of their skills. The results indicated that through problem-based TBL interventions, nursing students understood better the medical processes that patients went through, and their socio-emotional skills, confidence, and attitudes improved (Seymour, 2013).

Additionally, Seymour (2013) found that education, training, and experience significantly contribute to nurses' confidence. Ofstad and Bruner (2013) noted that in health care education, students struggle with critical thinking and lack confidence in decision-making with tests, estimations, and clinical practice. Therefore, the development of relevant skills through TBL helps students when they encounter high-stress, high-pressure days.

As highlighted previously, TBL interventions play a critical role in ensuring that students enjoy the learning process while simultaneously scaffolding their education through peer-to-peer interactions (Seymour, 2013). However, a limitation of this approach is that it may not apply to all nursing students. According to Sowan and Jenkins (2013), a hybrid, interactive nursing course that involves a great deal of research is vital to ensure that students learn from what they do. In their study, the researchers designed their hybrid course and delivered it (through the Tegrity and Blackboard systems) to 105 undergraduate nursing students in a scientific research in nursing course in Jordan (Sowan & Jenkins, 2013).

The researchers determined the effectiveness of the program by assessing students' satisfaction scores and comparing them with scores from another cohort that had taken the same course in a previous semester. Furthermore, they measured student satisfaction through a mixed-methods approach using a 29-item five-point Likert-type scale that also contained two open-ended questions. Then, the researchers matched groups based on the students' year in the program, gender, age, and GPA (Sowan & Jenkins, 2013).

In their findings, Sowan and Jenkins (2013) indicated that educators must follow seven core principles to ensure that they deliver a useful hybrid. The principles that the researchers identified included (a) high expectations, (b) helpful student-faculty contact, (c) prompt feedback, (d) cooperation among students, (e) active learning, (f) time on task, and

(g) respect for diverse talents and ways of learning. This study is consistent with previously cited research highlighting the importance of increasing lecturer immediacy (Chiou, 2014; Ruggeri, Diaz et al., 2008; A. S. Williams, 2010), prompt feedback and student-faculty contact (Hall & Vance, 2010), collaborative learning (Kinkead et al., 2016; Macheski et al., 2008), cooperation among students and multifaceted techniques (McGrath et al., 2015; Pan & Tang, 2004; Quinn, 2006), and diverse methods of learning. Student interaction and collaboration increased throughout this intervention, but the majority of students reported negative experiences with their group projects.

Only 55% of the students agreed that the group projects were helpful and improved their ability to complete the assignment. Thirty-five percent of the students reported that the group assignment was a joyful experience. While investigating why the students did not find the group projects a positive experience, Sowan and Jenkins (2013) discovered that only 50% of the students had accessed the group page at least once, potentially contributing to the negative feedback provided by some students. Consequently, the online format was responsible for the negative scores, rather than the specific curriculum or pedagogy. Therefore, this result is a gap in the research, which would be beneficial to investigate. These results indicate that the TBL curriculum could be more valuable for in-person classes, rather than through an online or hybrid course.

In a study conducted by Struyven et al. (2008), the researchers found that individual perspectives and different learning environments had an effect on the teaching and the level of student engagement during the course. In their study, the authors employed a lecture-based learning environment at different times for 608 students in their first year of an elementary teaching program in Belgium. The findings, obtained through a Course Experience Questionnaire, indicated that a collaborative learning environment influenced students more than the traditional lecture-based environment (Struyven et al., 2008). This outcome emphasizes the potential effectiveness of a collaborative learning environment, such as TBL.

Through the use of a curriculum that emphasizes TBL instead of traditional methods emphasizing individualistic assessments, attrition rates in the nursing program could decrease (Sowan & Jenkins, 2013). Using TBL may also increase student engagement (Ofstad & Brunner, 2013; Struyven et al., 2008). Additionally, increasing collaboration can effectively decrease SA (Seymour, 2013). The skills gained in TBL also effectively translate to those needed for clinical nursing practice (Sharkey & Sharples, 2003).

Team-Based Learning Advantages. The first and foremost advantage of TBL is that interventions facilitate the collaborative working of all parties involved in the process (Macke & Tapp, 2012). In their pre-test/post-test study design consisting of two groups (n=46) of graduate social work degree students from a Midwestern university, Macke and Tapp (2012) randomly assigned participants to either a TBL or non-TBL group to determine whether there were any significant differences between them. They discovered that the TBL method's success relies on robust collaborative frameworks between individuals, institutions, or both. First, this framework is critical because it ensures that all involved parties take part in the process and, therefore, maximizes the number of people who benefit. Second, TBL interventions improve student engagement, participation, and contribution to the learning process (Macke & Tapp, 2012). Furthermore, TBL emphasizes better self-efficacy in research. This study provides evidence of the link between TBL, self-efficacy, anxiety, and academic outcomes.

Instead of taking on a passive role where students wait for their professors to recite facts and merely copy them down, the TBL method promotes better student engagement, better learning, and positive student contributions (D'Souza et al., 2013). Notably, working in small teams plays a central role and helps guarantee that every individual could participate as much as possible. For nursing, this method is beneficial because it ensures that individuals can learn as much from their professors as from their peers.

Another advantage of a TBL approach is that it advocates fervently for peer leadership. By working in peer-led TBL teams, students are likely to learn and participate, which encourages independent research, as opposed to waiting for professors to provide them with answers (White et al., 2012).

Furthermore, the TBL interventions result in innovation and educational approaches that are viable to instruction; the TBL methods continue to redefine the bounds within which education exists. Moreover, the TBL approach is an essential tool for teaching, likely to influence future trends in education and instruction.

Assessing Team-Based Learning. Accountability is an essential element in TBL (Parmelee & Michaelsen, 2010). In their article describing 12 steps for using TBL in medical education, Parmelee and Michaelsen (2010) discussed how problem-based learning in group work improves classroom education and clinical skill. They stated that students are accountable for every activity that takes place in the group. Whether the work is completed individually or by the entire group, the members of the group must answer any questions directed to the entire group. If, for instance, the group is not performing well or some members are not producing content effectively, each team member can point out this behavior.

Moreover, each member must have the capability to solve the group's problems as part of the accountability aspect. Students must also receive timely and frequent feedback from their instructors (Parmelee & Michaelsen, 2010). The feedback relates mainly to the readiness assurance tests that the students usually participate in during the first class of the course. Students first take the readiness assurance test individually, then as a group. Both tests contribute to each student's final grade in the course, and therefore, timely feedback from the course instructors is necessary for the students to gauge their performance. Moreover, timely feedback allows students to correct their mistakes, and by changing their attitudes toward the process of learning, they have the potential for improved grades. As a result, timely feedback can help students improve their academic performance, which may translate into higher levels of SSE and lower levels of SA.

The final element of a successful TBL process relates to the assignment design carried out by the course instructors. Individual work, as well as the group assignments, must promote overall student development and individual learning. Therefore, the assignments should focus on developing student understanding and application of the concepts instead of just testing a student's ability to memorize concepts (Parmelee & Michaelsen, 2010). Furthermore, educators should set the assignments so that every group member must participate. Therefore, there should not be a scenario wherein only a few students contribute their knowledge while others are just spectators.

Assigning Groups. An additional consideration in TBL is that the instructor must select the group participants systematically. In the context of Parmelee and Michaelsen's (2010) study, they aimed to have the ratio of male to female students in each group as consistent as possible. This consistency aided in eliminating discrimination based on gender, and it helped generate different points of view. Race and ethnicity were also taken into consideration when assigning the students to groups. Thus, the selection procedure assisted in achieving a form of unbiased thinking.

Moreover, the researchers randomly selected the group participants, whereby high-ranking and low-ranking students were placed in a group together. They used a student's cumulative GPA in the nursing program to rank the students. The random selection procedure was critical to ensure that students with various degrees of academic success would work together. Also, they urged the students with higher GPAs to encourage the students with lower GPAs in the course concepts (Parmelee & Michaelsen, 2010). Additionally, they used the students' SA level (as the intervention pre-test determined) to dichotomize students into high anxiety and low anxiety students, which they also used when assigning students to teams.

Combined Individual and Instructional Level Interventions

The notion of a multifaceted teaching framework has been gaining popularity in statistics teaching due to its potential to improve SSE and to reduce SA by combining many different interventions into one integrated study. This strategy was studied by McGrath et al. (2015), who investigated how a multifaceted intervention influenced the statistics efficacy among students enrolled in a graduate-level statistics course. The researchers recruited 28 Canadian university graduate students and used the STARS and Current Statistics Self-Efficacy (CSSE) instruments to measure SA and SSE. The interventions the researchers applied in this study included (a) addressing the challenges of advanced statistics, (b) presenting research on persistence in mathematics, (c) using humorous cartoons, (d) showing a statistical music video, and (e) inviting past students to share personal anecdotes about experiences with statistics.

The researchers gave the interventions to the students in the experimental group, while they instructed students in the control group to read from a textbook during class time. As they hypothesized, the results McGrath et al.'s (2015) study revealed that a multifaceted teaching framework increased students' SSE and reduced SA. Additionally, McGrath et al. found that (a) the personality of the instructor, (b) the teaching methods, (c) the assessment methods, and (d) the clarity of the instructor's expectations and material they taught, were the factors that contributed most to the students' decreased SA and increased SSE. Therefore, these researchers recommended the use of a multifaceted teaching framework for reducing SA among graduate students. These results align with previous findings suggesting that educator immediacy and humor are useful methods for decreasing SA (Chiou et al., 2014; Epting et al., 2004; Miller et al., 2007; Ruggeri, Diaz et al., 2008; A. S. Williams, 2010).

Furthermore, these results were consistent with the findings of Pan and Tang (2004), who reported a significant relationship between multifaceted teaching methods and SA. Pan and Tang carried out a study comprised of 21 graduate students at a Midwest university enrolled in an introductory statistics course. The multifaceted intervention combined application-oriented teaching methods with instructors' increased attentiveness. In the application-oriented teaching, the students applied statistics to real-world applications (Pan & Tang, 2004).

In this study, Pan and Tang (2004) asked the students to write a letter biweekly to their bosses or friends explaining something they had learned in the statistics course that week. They also asked the students to critique a journal article applying the course content. The instructors combined encouragement and a humorous teaching style. They also addressed existing anxiety specifically. Furthermore, they sent an orientation letter to the students one week before the class started to increase the instructors' attentiveness to the students. The researchers also encouraged educators to have extra, flexible office hours. They gave the students the ability to bring a cheat sheet to the final exam and graded them on a pass/fail system (Pan & Tang, 2004).

The results of Pan and Tang's (2004) study showed that there is a significant correlation between application-oriented teaching strategies and SA. The results also indicated that there was an overall reduction of SA in this sample. Individual differences between participants— including age and the number of mathematics classes previously taken—also had a significant effect on SA in the sample (Pan & Tang, 2004). The study applied many different teaching strategies, making it difficult to tell which strategies contributed to the most significant decreases in SA. However, taken together, these findings provide evidence of the effectiveness of multifaceted teaching strategies in reducing SA.

Another multifaceted intervention study by Quinn (2006) that he designed to decrease SA examined (a) the effects of combining hands-on SPSS instruction, (b) group presentations, (c) in-class demonstrations with real data, (d) textbook readings, and (e) handouts showcasing statistics used in popular media. Participants included 13 University of New England social work students enrolled in a statistics course in which the researcher assessed SA using pre- and post-data from the STARS. The results indicated that these multifaceted instructional methods reduced SA. In particular, students reported that SPSS instruction, in-class demonstrations, popular media handouts, and group presentations were the most helpful in decreasing SA. Moreover, the textbook readings did not decrease SA. Additionally, students reported feeling comfortable using statistics and feeling significantly less SA when asked to read, interpret, and present findings using statistics after the intervention (Quinn, 2006). Therefore, this multifaceted intervention strategy was successful at decreasing students' SA using various methodologies.

The evidence presented on multifaceted teaching strategies indicates that the most helpful intervention educators can use to decrease SA is combining multiple existing interventions. Research indicates that useful strategies may include using a combination of humor (McGrath et al., 2015, Pan & Tang, 2004), showing statistics-based music videos (McGrath et al., 2015), using application-oriented teaching strategies (Pan & Tang, 2004; Quinn, 2006), and discussing personal anecdotes (McGrath et al., 2015).

Conclusion

In this literature review, the student investigator discussed strategies that effectively reduce mathematics anxiety and SA in college students. Such interventions included increasing self-efficacy (Hall & Vance, 2010; McGrath et al., 2015), value-reappraisal (Acee

& Weinstein, 2010), vicarious experiences (Bartsch et al., 2012), web-based instruction (Güzeller & Akin, 2012; Van Gundy et al., 2006), increasing lecturer immediacy (Chiou et al., 2014; Ruggeri, Diaz et al., 2008; A. S. Williams, 2010), using humor (DeCesare, 2007; Epting et al., 2004; Ford et al., 2012; Miller et al., 2007; A. S. Williams, 2010), religious motivation (Clark et al., 2008; Macheski et al., 2008; Mvududu & Larocque, 2008; Najjar et al., 2015), and multifaceted techniques (McGrath et al., 2015; Pan & Tang, 2004; Quinn, 2006). This chapter has explored each of those topics, evaluating their potential for use with adult nursing students enrolled in statistics-based courses.

The literature review provides evidence for the presence of SA among students, and especially those students in non-statistics majors, such as nursing (Blouin et al., 2009). As a result, the need to ensure the reduction of SA is a chief concern in higher education. The review also emphasized interventions as potential strategies that can increase the SSE and decrease the SA of students (Acee & Weinstein, 2010; Hall & Vance, 2010; McGrath et al., 2015).

Interventions using TBL are learning initiatives that improve the quality of education that an individual receives and ensures that learning is an enjoyable and exciting process (D'Souza et al., 2013; Kilner & Sheppard, 2010; Ofsted & Brunner, 2013). Consequently, the TBL approach may improve education because students may learn better once the educator has eliminated environmental and (some) personal problems (Hjeltnes et al., 2015; Sowan & Jenkins, 2013).

Furthermore, the TBL approach is vital to education because it can provide details on the challenges that cause anxiety among adult nursing students, identify how anxieties contribute to attrition within nursing and provide interventions that can overcome these challenges (Seymour, 2013). The TBL method effectively applies Vygotsky's (1978) principles of learning. Additionally, it ensures that learning institutions balance the ZPD in ways that learning is not wholly independent for the student yet not entirely dependent on the educator (Kozulin, 2003). In this way, learning becomes a reciprocating experience for educators and students.

TBL can be an essential asset in education to determine ways in which individuals learn. In the case of adult nursing students, factors such as stress, environment, educational institutions, and the intervention taken in educating individuals affect the success of the student in life, not just in learning (Kinkead et al., 2016). The current approach to educational interventions in many universities is exceedingly individualistic, with a high student-faculty ratio. Consequently, attrition rates in nursing programs continue to rise (Sowan & Jenkins, 2013). One way to overcome these challenges is through the incorporation and integration of a TBL educational approach within nursing schools and institutions. For this reason, the TBL method stands not only to improve the learning abilities of students, but also to change the interventions that programs use in educational delivery. Accordingly, these interventions may reduce attrition rates in the nursing field.

Students with high levels of SA may benefit from interventions that use collaborative teaching strategies. TLB and classroom collaboration can decrease SA when students have the opportunity to learn in a social environment where they can help each other work through the material. Therefore, conditions conducive to stronger communication between students and faculty decrease SA, improve SSE, and ultimately decrease attrition.

The needs assessment described in Chapter 2 identified SA in graduate students in a non-mathematics-based degree program. Although the sample that the student investigator used in the needs assessment differed from the one she used in the POP study, the results indicate that individual assessments, like tests and quizzes, contributed to high levels of anxiety in the participants. Consequently, the information in this chapter examining interventions illustrates that collaboration could be a decisive factor in addressing SA.

While each of the intervention strategies discussed in this chapter contributes to improved student learning, decreased anxiety, and increased self-efficacy in statistics courses, the intervention in the current study focuses primarily on TBL activities. The student investigator hypothesized that these activities would result in a value-reappraisal process through an emphasis on the benefits and uses of statistical techniques in the students' personal, professional, and academic environments. The TBL activities provided real-world experience for students, and the student investigator expected them to decrease SA and improve SSE by influencing the social dynamic between students. She also expected that increasing communication and discussion within groups would increase the mastery of the statistics subject by altering motivation and attention through the students' shared vicarious experiences. Overall, the use of these TBL interventions provides students with novel approaches to reducing SA and achieving improved academic performance in a statistics course and the nursing major.

The student investigator based the theoretical framework of the current study on the tenets of social cognitive theory (Bandura, 1986) and social development theory (Vygotsky, 1978). In an undergraduate nursing program statistics course, the student investigator used a multifaceted intervention using TBL combined with real-world applications, value reappraisal, and SPSS modules. Students worked on a research project in teams throughout the semester. Then, the student investigator had the students write a hypothesis to a research question of their choice. Finally, she collected the data and analyzed the results to form a conclusion. Based on this activity, she determined that the best intervention to support this learning was TBL using collaborative group work and real-world applications.

CHAPTER 4

Methodology

The problem of practice (POP) study examined statistics anxiety (SA) and statistics self-efficacy (SSE) relating to academic success in adult learners enrolled in an undergraduate college statistics class for nursing majors. As noted in the intervention literature review, the lack of SSE and high SA can hinder the learner's progress and potential. Quite a few researchers have determined that several adverse outcomes of SA have an impact on students (e.g., SA may prevent a student from having positive prospects for choosing a career in statistics-related jobs). Additionally, SA is a strong predictor of a student's performance in courses involving statistics (Vahedi, Farrokhi, & Bevrani, 2011). Experts recognize this issue as a concern for its impact on high attrition rates in nursing students; therefore, there is a need for successful methods to reduce SA in nursing students to lower attrition rates and meet the high demand for this profession.

According to Vahedi, Farrokhi, and Bevrani (2011), statistical examinations are highly anxiety-inducing, with research denoting that 80% of students who take statistical courses usually experience high levels of SA. During the needs assessment discussed in Chapter 2, students in education majors reported statistical tests as one of the most significant sources of SA for them when they took a research methods course containing statistics modules. Therefore, to decrease SA, it may be beneficial to use other methods of assessing learning in statistics courses. One such method, as the review of the literature illustrated in Chapter 3, includes using team based learning (TBL) projects.

Collaborative learning practices using TBL methodology appear to provide the most substantial decreases in SA (Seymour, 2013). TBL is a learning method that educators carry out between small groups of students, emphasizing how the students prepare themselves outside of class and how they apply the knowledge they obtained in the classroom

(Michaelsen & Sweet, 2011). The POP intervention that the student investigator conducted modified the existing course curriculum and pedagogy, switching from a traditional lecture and test format to a collaborative project, using data that the students collected, analyzed, and presented.

The current study aimed to utilize a mixed-method, quasi-experimental approach in examining how SA and SSE relate to the nursing student population. The results of the study can help fill in the gaps within the existing literature, providing new knowledge about the nature of the relationship between SA, SSE, and TBL. Additionally, these results can serve as a guideline for statistics educators about how to create a collaborative, interactive, and a pleasant learning context where students can learn from each other. Moreover, the value of this study may come from its potential to find useful ways to reduce attrition rates in nursing students. Additionally, the study may enhance the overall statistical literacy of this population, have some use in nursing practice and in nursing research to improve the general quality of the public health system. Ultimately, the goal of this study was to investigate the effect of a TBL intervention on SA and SSE in a statistics course for undergraduate nursing students.

Research Questions

1. In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?
2. To what extent does a team-based learning intervention affect undergraduate nursing students' statistics anxiety?
    a. To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?
3. To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?

a. To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students?

Research Design

A quasi-experimental, mixed-methods design was selected to evaluate the extent to which TBL decreases statistics anxiety in adult nursing students in the short- and long-term. Researchers often describe the quasi-experimental design as a nonrandomized pre-test/post-test intervention study (Grimshaw et al., 2000).

As the name suggests, a quasi-experimental design bears some differences from experimental design (A. D. Harris et al., 2006). It is different in that it makes no use of randomization in assigning subjects to treatment and control groups. It is similar to experimental designs in its goal, as it seeks to demonstrate causality between the dependent variable and the independent variables. In summary, a quasi-experimental study can utilize non-randomly selected groups as well as a pre-test/post-test intervention measurements. This description characterizes the current study. The students self-selected into sections of the statistics course; therefore, it was not possible to randomly assign them to a treatment or control group. As a result, students enrolled in the same course section likely had some factors in common with each other. For example, these students may have had similar work or family schedules or may have been in the same academic program or term in the program. Consequently, the most appropriate methodological design was quasi-experimental, but the student investigator expected that this approach might pose some limitations.

Strengths and Limitations of the Experimental Evaluation Design

Evaluation programs seek to determine the alignment of a project or intervention to the set objectives (Thackeray et al., 2018). The complexity of various objectives and the construction of the corresponding plans interfere with the theoretically known merits of the chosen evaluation design, thus triggering the need to study the strengths and limitations of the applied evaluation plan as dictated by the project of interest. Four advantages of the quasi-experimental design arise from its consistent use in education research (Shadish at al., 2002).

First, the design meets the practical requirements of school administration and ethics. As explained earlier, the design does not interfere with the placement of students in the classes and other administrative arrangements. Ethical considerations typically do not allow researchers to withhold an intervention when they established efficacy randomly, as is the case with TBL as an intervention; hence, the student investigator selected a nonrandomized design.

Second, the quasi-experimental design facilitates the evaluation of the effectiveness of an intervention, which the student investigator had tested and implemented before the evaluation procedure. In the case of this study, its focus was on the effectiveness of the TBL intervention. As an educational procedure, TBL is an established and generally accepted pedagogical practice (Ismail, 2016; Michaelsen, 2008).

Theory of Treatment

According to Leviton and Lipsey (2007), the theory of treatment (ToT) guides the process of data collection to reveal details of the causal process and serves as the framework to understand and interpret the intervention. Further, the ToT describes what is happening between treatments or interventions as well as inputs and outputs. The ToT related to this POP demonstrated that with the use of a TBL intervention, nursing students would have lower levels of SA. Moreover, lower levels of SA lead to higher levels of SSE and improved achievement in statistics courses, ultimately resulting in higher retention rates in nursing programs.

Researchers have four recommendations to develop an effective ToT: (a) define the problem correctly; (b) define the most effective elements of the treatment; (c) specify the mechanism through which the intervention is likely to affect the participants, and (d) define the magnitude of the effects (Leviton & Lipsey, 2007). In this context, the problem is that students are not choosing the nursing major or are dropping out of nursing programs due to high levels of SA and low levels of SSE in statistics courses. The critical components of this intervention were nursing students who wanted to learn, faculty who wanted to decrease SA, and curriculum/pedagogical shifts that aimed to decrease SA and improve SSE in statistics.

For this intervention to succeed, the adapted curriculum needed to demonstrate the clinical application of the course content, helping students recognize the value of the material. As students used the content to answer real-world research questions, the student investigator expected their SA to diminish while their SSE increased. As a result, she predicted that these students would not drop out of the class or the program. Researchers, such as McMullan et al. (2012), have found that several weeks is enough time to decrease SA and increase SSE in nursing students with mathematics anxiety. Therefore, the student investigator chose to have this intervention occur over one 16-week semester. The magnitude of desired effects was at a 0.05 level of significance between the pre-test/post-test intervention surveys. Accordingly, self-reported values for SA were assumed to decrease, while SSE was assumed to increase.

The ToT related to this POP was: If the instructor utilizes a TBL intervention, the nursing students will have lower levels of SA. Moreover, the student investigator expected that the lower levels of SA would lead to higher levels of SSE and improve achievement in statistics and other mathematics-related courses. The assumptions for this causal chain included that (a) changing SA will change SSE, (b) decreasing anxiety will improve achievement, (c) university instructors are willing to incorporate TBL into their curriculum, and (d) TBL is a useful learning strategy in statistics.

As stated by Leviton and Lipsey (2007), “The causal diagram identifies essential variables (as boxes or labels) and their causal influences (as arrows) on one another” (p. 38).

The ToT, shown in Figure 4.1, illustrates the relationship between SA, SSE, and academic achievement as a result of the TBL intervention. The model shows that anxiety and self-efficacy are short-term, intermediary outcomes, whereas improved achievement is a long-term outcome. As a result, the intervention is the independent variable, while SA and SSE are the dependent variables. The literature shows a relationship between anxiety and self-efficacy in statistics learning; therefore, these variables are related and both influence student achievement (Chiou et al., 2014; Macher, Paechter, Papousek, & Ruggeri, 2012; McGrath et al., 2015; Perepiczka et al., 2011). For example, researchers have found that numerical ability is the main predictor of nurses' drug calculation abilities. Therefore, if a nurse has difficulty performing accurate drug calculations, poor numerical skills are likely the cause of anxiety toward learning mathematics or a general lack of confidence in mathematics skills (McMullan et al., 2012).

The levels of SA and SSE were quantitatively measured in the participants using the Statistics Anxiety Measure (SAM), Current Statistics Self-Efficacy (CSSE), and Self-Efficacy to Learn Statistics (SELS) indicators. The student investigator initially predicted that if the intervention was successful, there should be a positive change in SSE and an adverse change in anxiety from the beginning of the semester to the end. Additionally, she anticipated that the qualitative data gained from her interviews would provide data about students' attitudes and beliefs, as well as how these attitudes and beliefs change throughout the semester.

The anticipated, long-term outcome of the student investigator's interest was student retention and that success in the statistics course would improve retention in the nursing program. She could not capture this additional component of the study through the initial data collection, but she included it in subsequent analyses.

Logic Model

The primary goal of a logic model (LM) is to supply stakeholders with a road map that details the sequence of related events, attaching the need for the planned program (or intervention program) to the program's desired results (Kellogg, 2004). In this context, the intermediate goal of this intervention was to decrease SA and improve SSE among adult nursing students (see Table 4.1). High SA and low SSE levels in nursing students may cause them to either drop out of the program or choose another major, inadvertently exacerbating the current nursing shortage. Thus, the objective of this POP study was to develop an intervention schema using team-based and collaborative learning aimed at reducing SA and improving course performance, with the long-term goal of preventing attrition.

The ToT and LM are useful to evaluate the intervention design and implementation, but they provide different information. The ToT included here is primarily outcomes-based and represents a causal model; it does not articulate the underlying assumptions of the intervention. The ToT links the outcomes to the intervention activities and shows how the change occurs. In contrast, the LM illustrates the intervention components by focusing on the outcomes, inputs, and activities not included in the ToT model; consequently, it more thoroughly describes the components. Therefore, to understand the full scope of the intervention project, it was beneficial to examine the ToT and the LM.

Process Evaluation

For fidelity of implementation of the TBL intervention to decrease SA in adult nursing students, the student investigator based it on five dimensions: (a) adherence, (b) participants' responsiveness, (c) exposure, (d) program differentiation, and (e) quality of delivery. Each of these dimensions has identifiable components or measurable indicators. In this process evaluation, the student investigator used an existing fidelity model in defining and measuring implementation fidelity for the POP extent did the implementation of the TBL intervention to undergraduate nursing students align with the proposed plan?

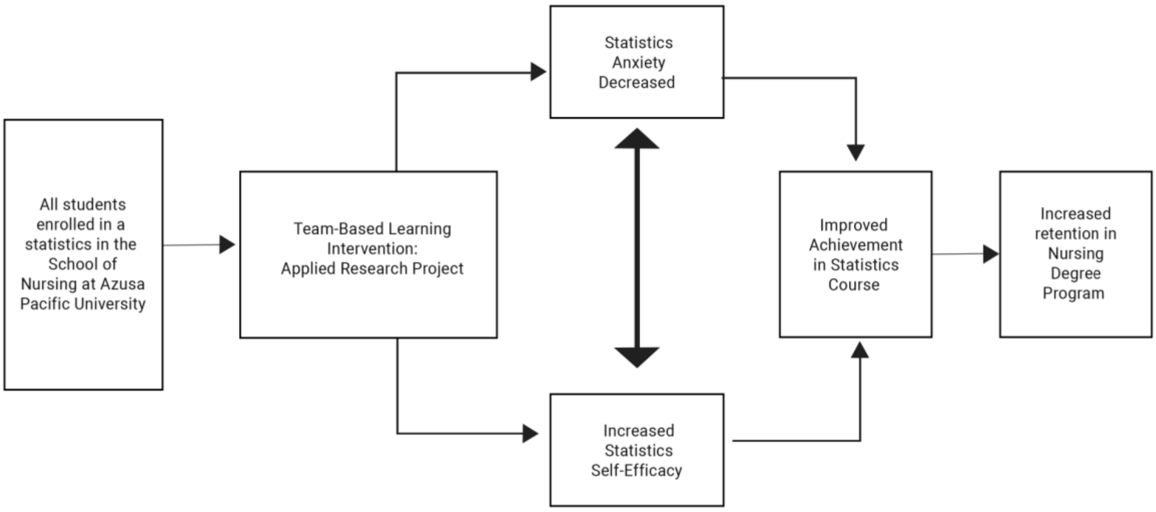
Using Swain et al.'s (2013) model, the student investigator measured fidelity of implementation, which maps the outcomes of the intervention using the Transfer Student Orientation (TSO) of the intervention's objective. The design entailed a checklist to appraise each of the fidelity components. The model redefined intervention objectives in terms of intervention features to achieve fidelity of the implementation. The design also incorporated an interface between intervention features, duration planned for each feature, and the actual duration. Recording each intervention feature by *Yes* or *No*, the student investigator further differentiated rating the quality of each implemented program feature on a scale (1=*Low* to 5=*High*).

The Intervention's Objective

The main objective of the intervention was to reduce SA among undergraduate nursing students, which the SAM can measure (Earp, 2007). The 43-item Likert-type scale measured six types of SA: (a) test and class anxiety, (b) anxiety related to the worth of statistics, (c) fear of asking for assistance, (d) computation self-concept, (e) interpretation anxiety, and (f) fear of statistics instructors. Consistent with the TSO model, the student investigator assessed the students' SA before administering the intervention and mapped measures to the pre-test component of the model. At the end of the TBL treatment, the she took post-test measures and mapped accordingly to assess the program's implementation fidelity.

Figure 4.1

Theory of Treatment



Note: The Theory of Treatment (ToT) explains the processes for the changes that occurred in this intervention.

Table 4.1

Logic Model

Resources/inputs	Activities	Outputs	Outcomes	Impact
Online learning system.	One 16-week semester.	100% participation rate for pre-and post- surveys.	Decreased statistics anxiety.	Increased retention in statistics courses.
Time for instructor and student investigator to meet.	Team-based learning; Student groups of 3-5.	10% participation in one-on-one interviews.	Improved statistics self-efficacy.	Diversity of assessments used to measure achievement.
SPSS licenses for each student.	Real-world application research project.	Biweekly meetings with faculty member.	More confidence with clinical competencies using calculations.	Decreased attrition in undergraduate nursing programs.
Technological platform for students to present virtually.	Writing a research question.		Overcoming past feelings of failure in mathematics subjects.	More people graduating with nursing degrees.
	Finding a validated instrument. Collecting data.		Decreased fear of general math.	
	Performing statistical calculations. Presenting results and conclusions. Identifying limitations, strengths, weaknesses, and biases.			

Table 4.1 (cont.)

Logic Model

Participation:
A. Three undergraduate statistics courses are offered online for nursing students in the Spring and Fall semesters, with about 20 students per section.
B. 120 students enrolled in an online undergraduate statistics course in the School of Nursing (60 students in the Spring and 60 students in the Fall).
C. 12 students will participate in one-on-one interviews with the student investigator.
D. There is one instructor who will participate in the intervention.
Assumptions:
A. The program used the current curriculum for 20 years, and the department may not see a need to make changes since it appears to be working.
B. The university curriculum committee will approve the proposed changes.
C. The instructor is willing to spend additional time and energy grading the applied learning project in place of the quizzes and final exam, which she will grade automatically using the online platform.
D. The instructor is invested in the intervention because she recognizes the impact that anxiety has on the achievement levels of her students.
E. The five modules integrate effectively into the curriculum.
F. The instructor agrees to meet biweekly to review the curriculum changes.
G. The instructor has the time and willingness to participate and adhere to the intervention protocol.
H. One semester is long enough to see a significant decrease in anxiety.
I. Team-based learning is effective in an online course.
J. Students will complete the pre- and post-intervention surveys.
K. Students will volunteer to participate in the one-on-one interviews after the class has ended.
L. Students who drop out of the course will still volunteer to participate in the one-on-one interviews.

Program Differentiation: Core Features Definition

As an intervention, researchers define TBL in terms of core features: which are the indispensable and essential elements of the intervention (Wallace et al., 2008). The core elements must be clear to ensure that the implementation program is useful. The four pillars of the TBL framework, according to Michaelsen and Sweet (2011), are (a) the formation of strategic, permanent, and heterogeneous teams, (b) the readiness assurance process, (c) team engagement in the prescribed activities, and (d) the peer evaluation process.

Additionally, they described four TBL pedagogical practices: (a) group and individual accountability, (b) structured discussions, (c) motivational aspects, and (d) feedback cycles, which include re-teaching (Applebee et al., 2003). Program adherence would, therefore, comprise fidelity to the four pillars of TBL and the four TBL pedagogical practices.

Exposure

In educational discourse, exposure evaluates the degree to which students in a program receive full treatment (Carroll et al., 2007; Swain et al., 2013). Apart from specifying the program features, program differentiation details the duration of each program element. Many of the education researchers cited above advocate for each student to receive the full dosage of each program feature. However, in reality, this rarely happens (Gerstner & Finney, 2013). In the current study, the TBL features continued throughout the semester. The student investigator could not realize a meaningful intervention if she shortened the duration. Moreover, elongating the treatment beyond the semester was not sustainable, as it may have resulted in an "overdose."

In addition to duration, the student investigator measured whether each participant received full exposure to all aspects of the program. According to Gerstner and Finney (2013), researchers cannot expect positive outcomes in cases where half of the participants miss the intervention aligned with the objective. Thus, the effectiveness of presenting a high-quality intervention for the duration significantly compromises the data if it includes non-attendees. Therefore, if the nursing students experienced the eight features (four pillars and four pedagogical practices of TBL) of the intervention throughout the semester, it is a 100% exposure rate, which equals success. Exposure was measured by counting the number of participants involved in each feature and recording the duration of their participation.

Intervention Adherence

This component assesses whether or not the features of TBL are implemented (Swain et al., 2013). Thus, adherence implies the opportunity to learn (Boscardin et al., 2005; Gee, 2003). The most objective way to assess adherence is to use live program auditors (Cochrane & Laux, 2008). The student investigator, therefore, audited the course and recorded if the instructor implemented the specific intervention features. Additionally, she asked faculty members to indicate if they adhered to the program features. For this implementation data, it was of primary importance that the instructor provided TBL opportunities.

The faculty member recorded two forms of data to assess adherence. They collected one by checking *Yes* or *No* for each of the four pillars of the TBL framework and the four TBL pedagogical processes. In contrast, they recorded the other as a percentage. If, for example, the intervention covered four out of the eight program features, the score was 50%. After that, the student investigator collected and reported the recording.

Quality

In higher education programs, how services are delivered is an integral component of interventions. Therefore, Suskie (2009) advocates for student-centered, high-quality programs. In the context of TBL, ensuring high-quality structured group discussions, such as a high level of interaction, plays a critical role in decreasing students' SA. Subsequently, the student investigator rated the quality of group discussions on a Likert-type scale from 1=*no interaction* to 5=*high quality group discussion*. The student investigator was responsible for recording based on her observations when she audited the class discussions.

Responsiveness

Participant responsiveness refers to the receptiveness of participants when the researcher exposes them to a program (Swain et al., 2013). Indicators of this aspect of the fidelity of implementation include the participants' (a) level of interest and enthusiasm, (b) perceptions about the usefulness and relevance of the program, (c) engagement levels, and (d) willingness to take part in discussions and activities. The participants' responsiveness mediate between the program and program adherence or quality of services.

Responsiveness was evaluated by a self-reported self–other assessment (see Appendix I). The student investigator asked each student to gauge group member responsiveness after submitting the final project at the end of the course. She expected various degrees of responsiveness from one group to another. Additionally, she used a Likert-type scale as a tool (1=*did not contribute at all* to 5=*vital and valuable levels of contribution*).

Summary of Fidelity Framework

Overall, the definition of the fidelity of implementation for the TBL aimed to decrease SA in adult nursing students, including the four pillars of TBL and the four pedagogical group activities. The implementer provided eight opportunities for the students' learning and program adherence so that the fidelity of implementation would occur; this was independent of whether or not all of the students participated. However, the eight program features extended throughout the semester to meet the intervention's objective. Most significantly, exposure to the eight features of the intervention required that 100% of the students participate in all of the activities throughout the semester; data of those who avoided participation would have rendered the intervention ineffective. In this POP study, exposure to the components of the fidelity of implementation significantly impacted the TBL intervention's outcomes—either positively or negatively.

Due to the asynchronous nature of the online course, the student investigator assessed the five dimensions of the fidelity of implementation without disrupting the regular course schedule. She reviewed the discussion boards at the end of each module and also monitored module exam grades, group work, and the final project (although the grading of each was the sole responsibility of the course instructor). Because there was only one instructor for the three classes, there was reliability between the consistency of instruction and any traits attributed to the instructor (i.e., their levels of anxiety or self-efficacy).

Outcome Evaluation

Many educational institutions are adopting conventional teaching practices premised on an integrated and learner-centered approach to improving the quality of education in the medical professions. Nurses confront different challenges in their work environment, highlighting the need for valuable teaching and learning practices they acquire in school. They require skills and knowledge to deliver quality care services (Onwuegbuzie, 2004). According to Jeffreys (2007), the challenges encountered by nontraditional, adult students over the age of 25, is found in adopting new strategies in the education system. Particularly, educators need to identify the most helpful approaches to use for students to engage in and pass statistical courses. In this context, there is a notion that nontraditional, adult undergraduate nursing students avoid courses that deal with statistics due to their fear of failure (Draves, 1986).

These students' conception of the complexity of mathematics lead to negative attitudes toward it and related subjects. SA reflects this attitude, which Onwuegbuzie and Wilson (2003) stated, is a critical barrier to achieving success in teaching and learning statistics. Subsequently, various researchers have focused on offering solutions to help improve teaching and learning statistics by improving SSE (Larwin, 2014; McMullan et al., 2012). By developing appropriate SA intervention strategies, Macher, Paechter, Papousek, and Ruggeri (2012) stated that there is an opportunity to increase academic achievement among nurses in statistics-related courses in higher education. Different types of interventions exist, e.g., some cognitive and non-cognitive strategies can reduce SA. Nevertheless, most of the research studies focus on cognitive aspects, suggesting that there is a gap in the knowledge of non-cognitive solutions.

The need to help students gain, retain, and apply knowledge has led to the application of the zone of proximal development (ZPD), the scaffolding established in Vygotsky`s sociocultural theory (1978). One of the tenets of ZPD is the difference between what an individual can do with the help of others compared to what they can achieve on their own (Lapkin et al., 2010). Through the application of ZPD in pedagogical strategies, students can address the challenges that they might have faced on their own with the help of their peers. Through the strategies premised on sociocultural theory, researchers have advocated for student-centered strategies that can meet the students' needs (Brandon & All, 2010; Phillips & Vinten, 2010; Rolloff, 2010).

The skills and knowledge gained in this student-centered context enable the students to use evidence-based strategies imperative for academic success in providing health care services. Innovative teaching practices are adjusted to enhance how instructors employ ZPDs in the education system. It is essential to create a balance in the learning environment, considering that there might be students at an advantage due to their academic and social-economic background (Daddow, 2017). Furthermore, Kozulin (2003) highlighted that the environment experienced by the students' impacts on their ability to learn. In this context, the environment includes the relationship emerging from personal experiences (Von Glasersfeld, 2005). The educational process prepares nursing students for future occupational responsibilities entailing their participation in the working society, being lifelong learners, and engaging in civic and cultural aspects of the society. These factors highlight the need for cooperation in acquiring an education, which teamwork can achieve.

In education, TBL has emerged as a strategic approach to formulate a useful pedagogy incorporating the concepts of ZPD and the development of a conducive environment that fosters success. Compared to traditional teaching strategies, TBL presents numerous advantages that support positive learning outcomes (Kilner & Sheppard, 2010).

Further reviews show that TBL can be useful to redefine instruction, teaching, and learning for nurses. In this POP study, TBL facilitated the socialization necessary in developing a nursing career.

Additionally, Kilner and Sheppard (2010) stated that TBL instructional methods can improve patient safety and reduce medical errors. The effectiveness fostered by TBL includes engagement and participation of the learners in group work and leads to a positive attitude toward learning (D'Souza et al., 2013). Furthermore, the use of groups in the learning environment increases the perceived value of the subject, contributing to improved academic performance. As a result, in many cases TBL is replacing the traditional methods of instruction for nurses taking university programs.

Therefore, TBL has facilitated changes in how nurses learn, interpret, understand, and apply the knowledge they gain in academics and practice. Adult nursing students experience fear when they fail to internalize the insights gained in any nursing class (Anderson & Thorpe, 2014), and the high levels of anxiety, frustration, and attrition impact their academic achievements and subsequent effectiveness in their nursing practice. Therefore, these adult nursing students need to see the value in any class they take and identify how they will use it in practice. From these insights, the application of TBL interventions highlights the opportunities that exist in how adult nursing students can address challenges compromising their success.

TBL has numerous benefits and advantages for nurses. According to Ofstad and Brunner (2013), TBL initiatives enhance communication and academic performance among students. Increasing the level of student engagement decreases the SA levels among students. A curriculum that utilizes TBL practices may reduce attrition rates associated with failure of statistics by increasing collaboration among students, which decreases SA, while the skills gained in teamwork translate into nursing practices (Seymour, 2013; Sharkey & Sharples, 2003). The collaborative learning environment facilitated by TBL ensures that all students contribute to the group, improving the self-efficacy of each individual, and leading to improved academic outcomes. The high levels of student engagement, participation, and contribution to the learning process improve the amount of information that learners can gain from their educators. The TBL pedagogy also advocates for peer leadership, motivating students to learn and participate in the learning process.

Therefore, TBL practices may be instrumental in developing innovative educational strategies that have the potential to redefine educational practices. The effectiveness of TBL shows that it is likely to influence future trends in education and influence instructional designs used for nurses.

Engaging nursing students in TBL facilitates a focus on the critical SSE elements that include mastery experiences, vicarious experience, verbal or social persuasion, and physiological or emotional states. According to Bui and Alfaro (2011), adult learners (those 25 years or older) report the highest levels of SA compared to traditional learners (ages 18–24), highlighting the need to apply TBL. Bull (2009) highlighted that nursing practices require high levels of precision in mathematical applications like administering medication, balancing fluids, calculating intravenous concentrations, keeping records, making measurements, and evaluating observations.

Research indicates that various factors contribute to drug calculation errors that include mathematics anxiety, compromised confidence, and inadequate numeracy skills (Andrew et al., 2009. As a result, students acquire the necessary skills in the learning environment to translate them into practice. Nevertheless, academic anxiety is high among nontraditional adult undergraduate nursing students, making the opportunities offered by TBL significant for individuals seeking higher education. The outcome evaluation draws from these insights to determine the components of the TBL interventions that are useful or not in reducing undergraduate nursing students' anxiety and facilitating self-efficacy beliefs. The student investigator, therefore, focused on the following objectives:

1. Determine how nursing students' SA relates to SSE.
2. Determine to what extent the TBL intervention affects undergraduate students' SA.
3. Determine to what extent the TBL intervention affects undergraduate nursing students' SSE.

Based on these objectives, the research question that investigates the outcome evaluation is: What components of the TBL intervention do nursing students identify as useful or not in reducing SA and facilitating SSE beliefs?

Methodology

The first phase of the study was a quantitative component, followed by a second qualitative phase. It was essential to critically assess which quantitative research approach was most suitable to meet study objectives. According to Grimshaw et al. (2000), the quasi-experimental design is ideal for a nonrandomized pre-test/post-test intervention study. The student investigator designed a mixed methodology procedure to address the research questions:

1. In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?
2. To what extent does a team-based learning intervention affect undergraduate nursing students' statistics anxiety?
    a. To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?
3. To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?

a. To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students?

Participants

A large, private, faith-based institution in Southern California was the setting of the intervention. The participants were individuals pursuing undergraduate nursing degrees. The control group included students enrolled in UNRS 299, an undergraduate nursing statistics course taught online in 2017–2018, while students enrolled in the same course during the 2018–2019 academic year formed the intervention group.

Recruitment

The student investigator invited all students enrolled in UNRS 299 to complete the voluntary survey. The procedure used to construct the sample was that recruitment was carried out by the student investigator, not by the professor, through electronic invitation. At the start of each semester, the student investigator contacted faculty who was teaching the course, and the faculty member provided email addresses of the students enrolled in the nursing statistics course that semester. The body of the email contained the invitation and the URL of the survey (see Appendix G). The survey was a requirement for online students as a non-graded, mandatory assignment. Since the student investigator conducted the surveys anonymously, it was not possible to ensure that each student taking the pre-test also took the post-test each semester. However, in some cases, the student investigator could link students based on demographic data.

Instrumentation

Statistics Anxiety

According to Onwuegbuzie (1997), factors such as interpretation anxiety, statistics test and class anxiety, computational anxiety, personality-related factors, anxiety related to asking for help, anxiety related to statistics instructors, and factors related to students' gender, age, study major, ethnicity, and college status impact the multidimensional construct known as SA.

Statistics Anxiety Measure. Intending to create a single, comprehensive measure that would integrate the aspects of the SA construct, Earp (2007) developed the Statistics Anxiety Measure (SAM). This instrument aimed to unite the theories of SA and attitudes toward statistics. Furthermore, it intended to bring together the commonalities of these theories, instead of examining them in opposition to one another.

According to Earp (2007), SAM is a measure that covers six factors of SA: (a) fearful behavior, (b) attitude, (c) expectations, (d) history and self-concept, and (e) performance. These six subscales made up the version of the scale that Earp used in the first pilot study (n=34), after which he reduced and redefined the factors, assessing the data with exploratory factor analysis (EFA). The revised scale with 60 items grouped in five subscales (anxiety, attitude toward class, fearful behavior, attitude toward math, and performance), was administered in the second pilot study, which sampled 347 statistics students at the University of Denver. EFA of the data confirmed the five-factor solution and resulted in a reduction of items to 43. Furthermore, Earp offered a simplified structure wherein SA and fearful behavior were combined.

The final administration of the scale sampled 433 statistics students. Additionally, Earp (2007) combined pilot and final administration data to examine the reliability and validity of the scale. She assessed model and item fit using confirmatory factor analysis, multidimensional item response theory, and Cronbach's alpha. The assessment demonstrated high reliability of the overall scale ($\alpha = 0.93$) as well as internal subscale consistency (α ranged from 0.82 to 0.95). Earp then assessed the convergent validity of the scale by administering two additional surveys that measured a similar construct. The analysis demonstrated that SAM is a measure of SA rather than a measure of attitude to statistics, a finding that emphasizes the need to conceptualize further and conduct research of SA.

According to Vahedi, Farrokhi, and Bevrani (2011), they examined the structure of SAM in a study (n=298) at Tabriz University in Iran. This study found that the five-factor model is an adequate measure of SA, and it confirmed the presence of a higher-order factor of general SA. The results reaffirmed the high internal consistency of the scale (α>90) and demonstrated that female students show higher levels of SA. The same authors used the scale in another study, which indicated that learning strategies and procrastination helped predict changes in SA. SAM measures the SA variable using 5-point Likert values (ranging from 1=*strongly disagree* to 7=*strongly agree*), wherein higher numbers in a given section indicate higher levels of anxiety in that domain (Vahedi, 2011). Additionally, it calculates an aggregate score to reflect overall SA.

Statistics Self-Efficacy. Self-efficacy is a person's level of confidence in his ability to perform specific tasks under specific conditions or situations; personal beliefs about performance precede outcomes (Bandura, 1977). Bandura (1977) also stated that "the outcomes people anticipate, depend largely on their judgments of how well they will perform in given situations" (p. 23). Prior experiences, personal beliefs, and vicarious experiences are influential in a person's development of personal self-efficacy. Self-efficacy is task-specific; thus, researchers should avoid general measures of self-efficacy since they decontextualize self-efficacy judgments (Pajares, 1996b). Instead, self-efficacy measures should be task-specific, rather than domain-specific.

Current Statistics Self-Efficacy and Self-Efficacy to Learn Statistics. According to Finney and Schraw (2003), current SSE is described as "confidence in one's abilities to solve specific tasks related to statistics" (p. 164), while self-efficacy to learn statistics is "confidence in one's abilities to learn the skills necessary to solve specific tasks related to statistics" (p. 164). Finney and Schraw created two measures for these constructs: CSSE and the SELS. They then used these constructs to survey the students enrolled in statistics courses at Midwestern University on two occasions (pre-test: n=140; post-test: n=130) using the 14-item scale.

The first administration of Finney and Schraw's (2003) survey confirmed the one underlying construct of both instruments after factoring analysis extraction criterion (scree and percent variance) and parallel analysis. Cronbach's alpha coefficient showed an excellent internal consistency reliability with a 0.975 score for the SELS and a 0.907-0.935 for CSSE. Additionally, the post-test results of CSSE showed a positive correlation with performance scores. Students who participated in the study demonstrated a significant improvement in self-efficacy over the 12-week instructional interval; CSSE scores increased by almost two standard deviations. Finney and Schraw found that "CSSE measure was positively related to the SATS subscales and these correlations were stronger for the post-test SATS scores than the pre-test SATS scores" (Finney & Schraw, 2003, p. 177), and that general and SA correlated negatively with CSSE.

As for SATS, pre-test results demonstrated a significant positive correlation between SATS scores and scores on the scales that measured statistics performance and attitudes toward statistics. Conversely, there was a negative correlation between SATS scores and anxiety. Overall, Finney and Schraw (2003) found that the CSSE and SELS measures could predict performance, serving as evidence of the measures' validity.

The CSSE and the SELS instruments measure the relationships between SSE and statistics performance and the increase of SSE at the beginning and the end of an introductory statistics course for groups of undergraduate students. Both the CSSE and SELS comprised a 14-question instrument that assessed self-efficacy using a 6-point Likert-type scale (1=*no* *confidence at all* to 6=*complete confidence*). The student investigator's calculation showed that higher levels indicate self-efficacy.

Statistics Student Survey

Both the SAM and SELS were combined into one survey titled the *Statistics Student Survey (SSS) Pre-Test* (see Appendix Q). Then, the SAM and the CSSE were combined into one survey titled the *SSS Post-Test*. Self-reported anxiety and self-efficacy levels were measured using electronic surveys. The students answered questions from the SSS that the student investigator administered electronically to the control and intervention groups at the beginning and end of the semester of the 2018–2019 academic year. Demographic variables provided as part of the pre-test and the post-test included the students' birthdate, gender, and ethnicity.

After the intervention, the student investigator collected the qualitative data. Then, the she sent an email invitation to the undergraduate nursing students enrolled in the online statistics course. The email asked the students if they would participate in a one-on-one interview with the student investigator about the implications of the intervention (see Appendix I). The interviews took place at the beginning of the semester following the intervention. For example, the student investigator invited students enrolled in the Fall semester intervention to join the one-on-one interviews that convened at the beginning of the Spring semester. The interviews allowed for a nuanced, vibrant, and dense dataset to validate the quantitative survey findings. Codes emerged from the interview data, and then categories emerged from the codes. Accordingly, the student investigator used these to create and identify thematic patterns.

Procedures

The Intervention

The online statistics course, UNRS 299, was divided into five modules, each of which covered several chapters from the course textbook. Initially, the class was entirely asynchronous; students communicated with the instructor through email and forum postings. In the TBL curriculum, the instructor held one synchronous session per module to review common themes related to the submitted group work. Additionally, the instructor invited teams to set up personal meetings with her via Google Hangouts.

In the control group in the statistics course consisting of sections of UNRS 299 occurring within the 2017–2018 academic year, there were 300 points possible. Activities included assignments, quizzes, faith integration forums, module exams, and a final exam (see Appendix G). In the intervention group with the TBL curriculum consisting of sections of UNRS 299 occurring within the 2018–2019 academic year, the instructor replaced the quizzes with a team assignment within each module, and she replaced the final exam with a group project (see Appendix H).

Quizzes

In the control curriculum, there were 14 short chapter quizzes, each of which consisted of five questions; the instructor dropped the two lowest quiz scores at the end of the course. Students had 10 minutes to take the quizzes online within a 3-day window. The questions were randomly drawn from a question pool, leading to students receiving different questions. The 12 quizzes (once the instructor dropped the two lowest scores) were weighted at five points each, representing a total of 60 points of the student's final score.

In the intervention curriculum, the instructor replaced the quizzes with small group assignments, all of which she incorporated into the final team-based project. The smaller group assignments that replaced the quizzes were each a piece of the sizable final project.

Student groups submitted these during each module and received feedback from the instructor. She also expected the teams to post their responses in an online discussion board for class input. Each team elected a member to serve as the team leader throughout the module; this person was responsible for posting the group's work to the whole-class discussion board forum. The team leader of that session was also responsible for addressing the questions posed in the thread by other classmates during that module. Every week, each team member was required to complete a self–other survey to identify the contributions of each member that week (see Appendix G). No grade was associated with the self–other survey, but the team score of the module was not released until each team member completed the survey. The goal of the self–other survey was to provide a measure of accountability and to provide a forum for students to discuss any aspects of the team dynamics that they wished their instructor to know.

Team Assignments

The team assignments were due by Friday of the second week of each module. The students received feedback through email by Tuesday of Week 3. Team discussions could be either synchronous or asynchronous, using any digital meeting tools that the team chose. The instructor did not monitor the team discussions; only the final postings and discussions on the posts were read and graded. Furthermore, the instructor allotted a total of 12 points for the teamwork during each module and gave each member of the team the same score for this work.

Most teams elected to utilize the Google Hangouts forum as a place to connect and discuss the team assignments. They would share documents on Google Docs and Google Slides so that the team members could be working on the same document simultaneously. On Wednesday of Week 3, the instructor held a synchronous session through Zoom that she recorded for any student unable to attend. On Friday of the third week of the module, students completed the module exam. For the last week of the class, students had dedicated time to complete their final projects and prepare to present them to the class. The students presented their final projects on the day that the instructor had designated the final exam.

Exams

Each module concluded with an exam covering the content from the assigned chapters in that module. The instructor ensured the control curriculum included a cumulative final exam that she administered at the end of the semester. She administered the exams on Examity, a format that enables students to use their laptops. The instructor also allowed for in-person proctoring of the exams because, even though the school offers statistics as an online course, the class was a face-to-face program across four regional campuses. Furthermore, the instructor used the module exams in the intervention curriculum to provide a measure of individual, time-based testing and to provide multiple opportunities for the students to study and recall; however, she replaced the final exam with a final project.

Faith Integration Forums

In two separate discussion board forums, the instructor asked the students to integrate concepts from scripture with nursing practice and statistical skills. In the first forum completed during Module 3, students read the *Florence Nightingale Pledge*, read four Bible passages, watched a video on lies and medical statistics, and reflected on their nursing experiences. In the second forum completed during Module 5, students learned about mistakes and malpractice in statistics and reflected upon what an ethical Christian nurse should do in different situations. In both forums, students posted one response to the prompt and then engaged in discussions with other students throughout the module.

Statistics Modules

In the 16-week semester, each of the five modules was open to students for three weeks, with one additional workweek at the end of the semester for final project preparation.

The group project of each module was due on Week 2 of the module, and the instructor gave the exam on Examity on the final Friday of the third week of the module.

Module 1. This module covered textbook Chapters 1, 2, and 3. These chapters covered evidence-based practices, statistics essentials, and levels of measurement. In the control curriculum coursework, there were three quizzes, one homework assignment (on levels of measurement), and a module exam. In the intervention curriculum, the instructor replaced the quizzes with a group assignment. The instructor asked the students to create a hypothesis comparing two or more different groups and then to search through the research literature to find studies related to their topic of choice. They were then asked to submit a copy of their hypothesis, define their variables of interest, and submit a survey that they intended to use to collect data, identifying at least one question from each level of measurement (nominal, ordinal, and continuous).

Module 2. The students learned about descriptive statistics and how SPSS can be used to organize and display data. The module covered textbook Chapters 4, 5, and 6. The control curriculum contained three quizzes, one assignment (on descriptive statistics), a faith integration prompt, and a module exam. In place of the quizzes, students in the intervention worked on their group projects and submitted various components for feedback. At the end of the first week of Module 2, the instructor expected the students to survey 60 to 90 people to gather data on their topic. In the second week of the module, they used the data they had collected to create frequency tables, display histograms, and calculate descriptive statistics.

Module 3. This module covered textbook Chapters 7, 8, and 9, reviewing hypothesis testing and relationships between variables. The control curriculum of this module included three quizzes, two assignments (one on correlation and one on regression), and a module exam. In Week 2 of the intervention curriculum of this module, students completed a statistical test based on their data and submitted the raw table and summary table for feedback.

Module 4. Students read textbook Chapters 10 and 11, learning about linear regression and tests to compare group means. In the control curriculum, there were two quizzes, one assignment (on *t*-tests), and one module exam. By Week 2 of the intervention curriculum module, students summarized their findings and submitted a draft of their analysis for feedback.

Module 5. The final module focused on Chapters 13, 14, and 15 and taught students about nonparametric tests and categorical data. The students in the control group took three quizzes, completed two assignments (one on nonparametric tests and one on chi-square), responded to a faith integration prompt, and took a module exam. In the intervention curriculum module, student teams wrote up the strengths, limitations, and implications for future research and posted them to the class discussion board for feedback.

The Workweek. In the control group, students used the workweek to prepare for their final exam. In the intervention group, this final workweek gave students time to make final revisions to their projects. In the control and intervention groups, the workweek provided time for the students to review course material and to meet with the instructor for any last-minute clarification.

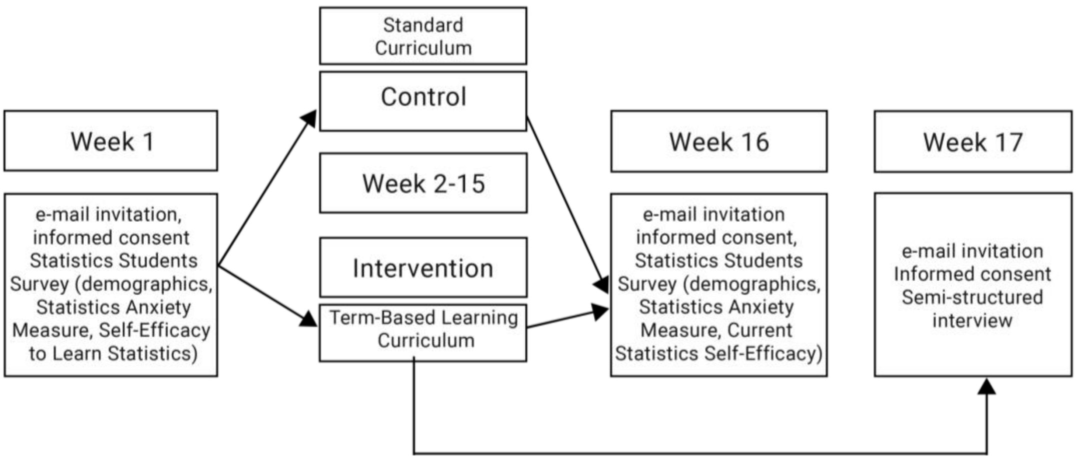
The **Final.** In the control curriculum, students completed a 2-hour multiple-choice exam. In the intervention group, student teams presented their data, findings, and results in a visual presentation to the class on the day designated for the final exam. Teams were allowed to use any technological software (like PowerPoint) to create a presentation to share with the class using an online media platform (e.g., YouTube).

Data Collection

The student investigator collected the data from this project in several stages over two semesters (see Figure 4.2). The same faculty member taught the same courses in the control and intervention semesters. The instructor taught the Spring term, according to traditional teaching methods—lectures and individual exams—and collected data to serve as a control group. In the Fall term, the instructor applied the intervention and TBL practices to the curriculum. Therefore, the instructor taught the courses using discussions and group projects and collected data from these classes as the intervention group. In the first stage of data collection, therefore, the instructor distributed the initial SSS surveys in the first two weeks of the class. In the next stage of data collection, the instructor administered another SSS in the last two weeks of the class.

Figure 4.2

Schedule of Data Collection Activities



The statistics instructor met in-person with the student investigator twice a year, once in Winter and once in Summer. In the academic year leading to the intervention, the student investigator and instructor met monthly over Google Hangouts. For the intervention planning, the instructor and student investigator corresponded using email and shared Google Docs to review the syllabus, course assessments, and lesson plans. Throughout the control and intervention periods, the instructor and student investigator met over Google Hangouts bi-weekly to discuss the course and to assess the curriculum.

Once the student investigator obtained SA and SSE Google Forms data from the students, she recorded it, transformed into Microsoft Excel files, and then imported it into SPSS. She included the alignment between the research questions, construct, instrument, and specific data source items in the research summary matrix (see Table 4.2 and Appendix H).

Data Analysis

Quantitative Data Analysis

Univariate analyses were performed between gender, race, age, and self-efficacy to evaluate the impact of these demographic variables on anxiety and self-efficacy. The student investigator conducted DID regression, correlation, and canonical correlation calculations to address the research questions. The quantitative methodology that best-addressed Research Question 1 was correlation and canonical correlation, and the quantitative methodology that best-addressed Research Questions 2 and 3 was DID regression.

Canonical Correlation

Correlation is a standard statistical technique that shows how strongly, if at all, pairs of variables are related (Lappe, 2000). Canonical correlation is the study of the linear relations between two sets of variables; it is a multivariate extension of correlation analysis (Vahedi, 2011). Therefore, the student investigator used canonical correlation analysis to examine the relationships between SSE and the five subscales of SA, and then computed the Pearson correlation and canonical coefficients. In this intervention study, the student investigator used a canonical correlation to examine the linear relations between the control group or intervention group, depending on the curriculum used.

Table 4.2

Research Summary Matrix Showing the Alignment of Research Questions with Instrumentation and Data Source

Research question	Construct	Instrumentation (Data source)	Items in data source
Question 1: In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?	Relationship between SA and SSE.	Surveys	Cumulative scores
		A. SAM (Earp, 2007)	A higher score indicates higher levels of SA.
		B. CSSE and SELS (Finney & Schraw, 2003)	A higher score indicates higher levels of SSE.
		Interview	Semi-structured interview questions.
Question 2: To what extent does a TBL intervention affect undergraduate nursing students' statistics anxiety?	Comparison of SA between intervention and control groups.	Surveys	Cumulative scores
		A. SAM (Earp, 2007)	A higher score indicates higher levels of SA.
		B. CSSE and SELS (Finney & Schraw, 2003)	A higher score indicated higher levels of SSE.
		Interview	Semi-structured interview questions.
Question 2a: To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?	Comparison of SA between intervention and control groups by age, gender, and race.	Surveys	Cumulative scores
		A. SAM (Earp, 2007)	A higher score indicates higher levels of SA.
		B. CSSE and SELS (Finney & Schraw, 2003)	A higher score indicates higher levels of SSE
		C. Demographic variables	Age, gender, race.
		Interview	Semi-structured interview questions.
Question 3: To what extent does a TBL intervention affect undergraduate nursing students' statistics self-efficacy?	Comparison of SSE between intervention and control groups.	Surveys	Cumulative scores
		A. SAM (Earp, 2007)	A higher score indicates higher levels of SA.
		B. CSSE and SELS (Finney & Schraw, 2003)	A higher score indicates higher levels of SSE.
		Interview	Semi-structured interview questions
Question 3a: To what degree do age, gender, and race influence the effect the intervention on statistics self-efficacy in undergraduate nursing students?	Comparison of SA between intervention and control groups by age, gender, and race	Surveys	Cumulative Scores
		A. SAM (Earp, 2007)	A higher score indicates higher levels of SA.
		B. CSSE and SELS (Finney & Schraw, 2003)	A higher score indicates higher levels of SSE.
		C. Demographic variables	Age, gender, race.
		Interview	Semi-structured interview questions.

Difference-in-Difference Regression

The student investigator used a DID regression study design to analyze the association of the curriculum (intervention or control) on anxiety and self-efficacy.

This research approach utilized outcomes observed in the two groups (one taught the traditional way—the control group—and the other learning with the help of the TBL

intervention—the experimental intervention group) over two periods (the pre-test at the start of the course and the post-test at the end of the course). The instructor exposed the treatment (TBL curriculum) to the intervention group in the second period (post-test), but not in the first period (pre-test). She did not expose the control group to treatment (TBL curriculum) during either period (pre-test or post-test).

When the instructor observed the same units within a group in each period, she subtracted the average gain in the second (control) group from the average gain in the first (treatment) group. The benefits of the DID regression approach include removing biases in second-period comparisons between the treatment and control group that could result from permanent differences between those groups, as well as removing biases from comparisons over time in the treatment group that could be the result of trends (Cataife & Pagano, 2017).

The DID regression approach calculates the normal difference in the outcome variable between the control and experiment group (the difference that would exist if neither group experienced the treatment). The treatment effect is the difference between the observed outcome and the normal outcome (Cataife & Pagano, 2017). The student investigator compared the changes in anxiety and self- efficacy scores of the students in the current study who had been given the standard curriculum to the students who had been given the TBL intervention curriculum. She also used three sets of linear regression models to evaluate the association between anxiety and self-efficacy and curriculum.

The first linear regression model was unadjusted. Namely, the student investigator regressed the outcomes (anxiety or self-efficacy) to the binary indicator at the time of survey completion (beginning or end of the semester), the binary indicator of the student receiving the curriculum (standard or TBL intervention curriculum), the interaction term for the DID effect at the time of survey completion (pre-test or post-test), and the curriculum the student received (control or intervention):

$$Otcome = \beta_0 + \beta_1 * survey + \beta_2 * curriculum + \beta_3 * survey * curriculum.$$

In the second set of models, the student investigator controlled gender (male or female), age group (traditional or adult), self-efficacy (continuous), and anxiety score (continuous) at the time of survey completion. In the third model, she further controlled the components of the anxiety score with the self-efficacy outcome. Additionally, she set a *p-value* of less than 0.05 a priori for statistical significance. The student investigator completed all analyses in SPSS v24.

Power

Furthermore, the student investigator used the R package *pwr* (version 1.2-2) to perform a power analysis of the Pearson correlation coefficients between anxiety and self-efficacy. No packages or software were available to evaluate the power of the canonical coefficients. She completed all power analyses in R version 3.5.1.

Effect Size and Sample Size

The effect size, or the minimum detectable effect size, describes a parameter that could inform researchers about the extent of the true difference between the comparable groups in a given population as opposed to the study sample. Furthermore, effect size has an inverse relationship with the required sample size in a given study to attain an adequate power. The more significant the difference between any given parameter of comparable groups in a population, the easier it is to detect. Therefore, it requires the detection of a smaller sample size. Similarly, if a given parameter exhibits a small difference between comparable groups in a given population, it requires a larger sample size to detect the difference at an adequate power.

As it is not possible to measure the true effect size in a given population, the best approach is to base it on the most extensive study known that has the closest study design. The student investigator identified a previous study by Carpenter et al. (2007) that had adopted a similar study design (i.e., compared the effect of TBL on individual learning in a total of 99 students). Therefore, she used that study to identify the relevant effect size in the population and the required sample size for the current study.

The study by Carpenter et al. (2007) compared the influence of team teaching on graduate students' comfort with their statistics and research course that was team-taught (n=55) compared to students who were solo-taught (n=44). The study observed a significant difference in final grades between the team-taught and solo-taught sections with an effect size of 0.43. The differences in the characteristics of the students enrolled in each section explain the differences in the final grades between the two groups. The students in the TBL section of the Carpenter et al. study were predominantly preservice educators who were yet to assume full-time responsibility as educators. In contrast, working professionals pursuing further studies dominated the solo-taught section. The present study, on the contrary, used undergraduate nursing students rather than preservice educators.

Although the Carpenter et al. (2007) study and the current study used similar data from a statistics course, comparing the effects of TBL in an intervention group to a traditionally taught control group, the outcomes of interest differed. While the study conducted by Carpenter et al. assessed comfort levels, the present study examined anxiety and self-efficacy. Thus, the results from Carpenter et al. may not be generalizable to this POP study. Nevertheless, the effect size reported by Carpenter et al. was the best available evidence from the literature and was adopted to compute the sample size required for the present study.

Qualitative Data Analysis

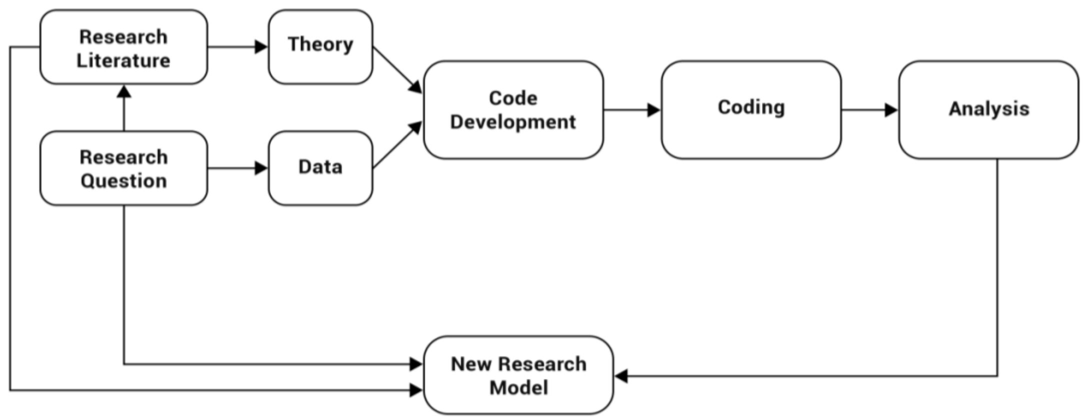
The student investigator collected the qualitative data from interviews she had conducted with the intervention group who had completed the online statistics course in the previous semester of the 2018–2019 academic year. After the instructor had posted the final grades for the course, she sent each student an email with an invitation to meet with the student investigator and discuss the statistics course. Then, the instructor asked the students who were interested to join using Google Docs, and the student investigator conducted the interviews using Google Hangouts. She scheduled each interview in 1-hour blocks, expecting the interview to last about 45 minutes. After recording the interviews with the nursing students, the student investigator sent the audio recordings to rev.com for transcript services. Following the thematic analysis approach, she then analyzed the qualitative data. The following section describes how the student investigator conducted the thematic data analysis using Braun and Clarke's (2013) six-step thematic analysis approach.

Thematic Analysis

Thematic analysis is a useful way to look through large volumes of qualitative data, which may, at first glance, seem unmanageable and disjointed. Researchers can apply thematic analysis to a wide variety of datasets and use them to address various kinds of research questions. Researchers think of thematic analysis as a cluster of methods that focus on identifying patterns and themes in a dataset. The different approaches of thematic analysis share a focus on identifying themes in qualitative data and share some degree of theoretical flexibility. However, they can differ in the underlying philosophy and procedures required to produce themes. Figure 4.3 depicts how thematic analysis produces a new research framework after the researcher collects the qualitative data. Collected data and theory go into code development and help with the coding process, leading to the formation of themes and the implementation of the analyses.

Figure 4.3

The Process of Thematic Analysis



The researcher applies thematic analysis methodology during the problem framing stage in a research process, which helps them move from a broad reading of data toward the discovery of patterns, themes, codes, and framing of a specific research question. Thematic analysis was appropriate for the research questions in this study for a variety of reasons (see Table 4.3).

Familiarity with the Data. The first step in becoming familiar with the data was that the student investigator read and reread the qualitative data that she had recorded and transcribed using rev.com. In this initial stage of reading, the student investigator wrote down initial codes and formed views on initial patterns and themes. A priori codes came from the research questions and theoretical framework. The student investigator used analytical memos between coding and writing up the results. Memos provided additional insight into the research process whereby she jotted down any important observations (facial expressions, change in voice tone, or even group interactions; Noble & Mitchell, 2016) during the interview. Memo-writing provided an audit trail of the student investigator's thinking. Therefore, memo-writing was another layer of insightful data that she collected during the interview process.

Creating Initial Codes. The second step of the thematic data analysis was coding the qualitative data using the NVivo software program. The student investigator coded one to three lines of text at a time; during this process, she identified essential words, concepts, images, and reflections. Coding is an iterative process in which the researcher modifies the coding or analysis as it reflects the data, and as ideas and themes emerge. A code should capture the qualitative richness of the data with clarity and conciseness. Additionally, the researcher should state why the code is there, its boundaries, and how to know it when it occurs.

Validation of Codes. The third step was code validation, a step intended to ensure codes are not misinterpreted and are bias-free. The student investigator reread the data and double-checked the codes for consistency and validation. Then, the integration of the codes from the data became the framework from which themes emerged.

Creating Themes. Once there was a comprehensive list of codes, the fourth step was to cluster these codes into overarching themes to represent the data accurately. The student investigator needed to describe what the themes meant, even if they did not fit into the overall research process. Accordingly, themes emerged from patterns, such as conversation topics, and vocabulary, and the frequency of occurrence.

Finalizing Themes, Definitions, and Names. The fifth step in the thematic analysis was when the student investigator finalized the names of each theme, wrote the description of the themes, and illustrated them with some quotations (verbatim) from the original text to help communicate each theme's meaning to the reader.

Table 4.3

Alignment of Research Questions with Analysis Methods

Analysis methodology	Justification	Assessment tools
Question 1: In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?		
Pearson r, correlation	Assessing the relationship between two continuous variables	Cumulative scores for total anxiety and total self-efficacy from the SSS
Canonical correlation	Assessing the relationship between self-efficacy with the subscales of anxiety	Cumulative scores for total self-efficacy and subscale scores for anxiety (general anxiety, performance, attitude toward class, attitude toward math, and fearful behavior) from the SSS
Question 2: To what extent does a TBL intervention affect undergraduate nursing students' statistics anxiety?		
The difference in difference regression (DID)	SA is the continuous outcomes of interest. Intervention is the independent, binary variable.	Cumulative scores for total anxiety from the SSS.
Semi-structured interview	Open-ended questions allow students to elaborate on their specific experiences and feelings	Thematic analysis
Question 2a: To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students'?		
The difference in difference regression (DID)	SA is the continuous outcome of interest. Intervention, age, and gender are the independent, binary and categorical variables.	Cumulative scores for total anxiety from the SSS. Age, gender, and race from the demographic data on SSS
Semi-structured interview	Open-ended questions allow students to elaborate on their specific experiences and feelings	Thematic analysis
Question 3: To what extent does a TBL intervention affect undergraduate nursing students' statistics self-efficacy?		
The difference in difference regression (DID)	SSE is the continuous outcome of interest. Intervention, age, and gender are the independent, binary and categorical variables.	Cumulative scores for total self-efficacy from the SSS. Age, gender, and race from the demographic data on SSS
Semi-structured interview	Open-ended questions allow students to elaborate on their specific experiences and feelings	Thematic analysis
Question 3a: To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students'?		
The difference in difference regression (DID)	SSE is the continuous outcome of interest. Intervention, age, and gender are the independent, binary and categorical variables.	Cumulative scores for total anxiety and total self-efficacy from the SSS. Age from the demographic data on SSS
Semi-structured interview	Open-ended questions allow students to elaborate on their specific experiences and feelings	Thematic analysis

Producing the Report. The sixth step entailed writing up the report once the codes, themes, definitions, and quotations were in place. Upon further reflection, this led to a period of introspection and modifying of the themes.

Reflecting on Thematic Analysis

Thematic analysis is useful when researchers collect data in different phases of a project and compare them afterward. In this POP study, the student investigator used data from pre-and post-tests and control and intervention groups. This approach was flexible enough to analyze data that might have appeared disjointed. Moreover, the student investigator used thematic analysis to gain insight and knowledge from the data she gathered, providing insight into the quantitative data findings from the qualitative data. Finally, she used thematic analysis to distill data, determine broad patterns and themes, and enable her to conduct more granular research and analysis.

This qualitative data analysis method was inductive in that the thematic analysis method allowed themes to emerge from the qualitative data gathered. These themes were not imposed or predetermined by the student investigator. Using the findings, she applied the thematic analysis method to validate codes and ensure that she had left nothing significant out of the analysis or that there was bias in the research process.

The thematic analysis approach was adopted to identify the difference in anxiety levels due to a TBL intervention for several undergraduate nursing students. The thematic analysis approach was a sound way of attaining rich and dense data with which to look at the decrease in anxiety levels once the statistics course evolved from a lecture and test-based class to a TBL format. Furthermore, the thematic analysis approach noted the difference in anxiety levels with the help of a properly constructed questionnaire.

One of the advantages of the thematic analysis methodology is the flexibility it brings to the analysis, management of large amounts of data, and uniting large teams of qualitative researchers. However, that flexibility may also make it difficult for the researcher to concentrate on specific aspects of the data. Therefore, a theoretical framework is vital to conduct a thematic analysis because the thematic analysis method has limited interpretive power on its own. In this study, the theoretical framework consisted of the theory of andragogy (Knowles, 1980), social cognitive theory (Bandura, 1986), and social development theory (Vygotsky, 1978).

Summary of Qualitative Methodology

Once the student investigator collected and transcribed the data, this completed the initial reading of the data. Then, she analyzed the data using NVivo, coding, and validating the data on a sentence-by-sentence basis.

Ethical Considerations

This study's ethics were maintained by first gaining IRB approval at the university the student investigator attends as well as the university where she conducted the research. This dual approval allowed the student investigator to conduct the study and to use the specified research questions. Furthermore, the student investigator requested the participants' consent via an email invitation (see Appendix F). The invitation detailed the study's purpose and assured the students that their responses would be anonymous (the student investigator did not ask the students for personal information [i.e., name, email address, or student ID]). The invitation told the participants that if they opened the link voluntarily and completed the survey, they were signifying that they understood and agreed to the terms of the study and consented to take part in it. As it was essential to preserve participant anonymity and keep the documents secure, only the student investigator had access to the student responses, which she stored on a password-protected computer in a locked office. Moreover, she assigned pseudonyms to the students who had completed one-on-one interviews.

For this TBL intervention, the faculty altered the curriculum to include a 16-week semester-long research project wherein the students worked in team-based work groups, writing a research question, finding a validated survey, collecting data, calculating statistics, and reporting the findings. This approach utilized TBL, demonstrating it as an effective, valuable strategy for decreasing SA.

Trustworthiness

This study was trustworthy primarily due to its use of the triangulation process. The first part of the research—the quantitative pre-test/post-test intervention SSS survey—tested the level of statistics course-related stress for the pre-test/post-test. The second part of the research was qualitative, which comprised in-depth interviews with nursing students enrolled in the statistics course. The qualitative findings strengthened the conclusions of the quantitative study and brought in new compelling data as well. Furthermore, by keeping the sample the same for both parts of the mixed-methods quasi-experimental study, the student investigator ensured that the participants had answers to the questions raised in the interview, which safeguarded the accuracy of the findings.

Potential Limitations and Biases

The university policy for course consistency precludes using a true experimental design; therefore, it was not possible to have a true control group. Additionally, due to the quasi-experimental nature of the study, students self-selected into specific classes through the cohort model. Therefore, students in each class had qualities in common with each other beyond selecting the course.

The student investigator conducted the intervention at a large, private, faith-based university in Southern California, and included only students who were pursuing a nursing degree. This small sample may affect external validity as the results the student investigator obtained may not be generalizable to all statistics students. The student investigator worked in the same school in which the nursing courses were taught, but did not teach any online, undergraduate, or nursing-specific courses. Therefore, the she did not interact with any of the participants before the study commenced. Part of the assessment process entailed giving the students the SSS as a pre-test/post-test measure; however, this may have introduced a test-retest bias, which may have been a potential threat to internal validity.

Conclusion

The literature showed that SA is negatively related to overall performance in statistics courses (Lyons & Beilock, 2012; Zeidner, 1991). Self-efficacy is similarly related to performance. Students with higher levels of SSE are successful to a greater extent in solving statistics problems and receive higher overall grades in these courses (Finney & Schraw, 2003). Additionally, researchers have found that students with SA delay registering for statistics classes until later in their studies, potentially impeding progress or preventing completion of the degree (Onwuegbuzie, 2004). Therefore, the goal of this study was to administer an intervention that would decrease students' SA and improve their SSE, ultimately improving their overall performance in the course and the nursing program.

The expected outcomes of this study were that the nursing students would have decreased SA, improved adeptness in countering past feelings of failure, and a decreased fear of numbers. These outcomes are relevant clinically because nursing students would have improved confidence in their abilities to use mathematics in the clinical setting when conducting drug dosage calculations and other numerical-based activities. Due to the availability of online and distance learning technologies, updated instructional materials and pedagogy, and support from higher-level administration, the student investigator expected that students would exhibit greater confidence and willingness to participate in the pre-test/post-test intervention surveys and interviews.

The sample comprised undergraduate nursing students enrolled in an online statistics course. The intervention applied TBL components. Moreover, the student investigator measured SA and SSE levels using a pre-test/post-test for control, intervention groups, and validated survey instruments to determine whether student anxiety and self-efficacy changed as a result of the intervention. In this study, the student investigator manipulated the intervention (the independent variable). Self-efficacy and anxiety were correlated such that as anxiety increased, self-efficacy decreased. Moreover, moderating variables included gender and age.

Furthermore, the student investigator used validated survey instruments and focus group interviews when collecting data in the mixed-methods, quasi-experimental approach. She also administered SSS via pre-test/post-test intervention surveys to collect quantitative data related to SA and SSE. Then, she conducted individual, post-intervention interviews to gather qualitative data relating to the knowledge, attitude, beliefs, and perceptions of the study's participants. These data informed the student investigator of the effects of the TBL intervention on anxiety and self-efficacy in undergraduate nursing students enrolled in UNRS 299, an online statistics course.

CHAPTER 5

Results

This problem of practice (POP) study aimed to investigate how team-based learning (TBL) affected statistics anxiety (SA) and statistics self-efficacy (SSE) in undergraduate nursing students. The goal was to address the research questions:

1. In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?
2. To what extent does a team-based learning intervention affect undergraduate nursing students' statistics anxiety?
    a. To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?
3. To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?
    a. To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students?

The student investigator implemented qualitative and quantitative methods to examine how the TBL strategy affected the students' SA and SSE. A quasi-experimental pre-test/post-test research design was selected to evaluate how TBL decreases SA or increases SSE in adult nursing students. Those in the control group studied statistics according to the traditional curriculum, while the student investigator implemented TBL in the intervention group. Furthermore, she examined the outcome differences of each group by analyzing the collected data. The nursing students enrolled in statistics in the 2017–2018 academic year were part of the control group (n=28), while students enrolled in the 2018–2019 academic year were part of the intervention group (n=68).

The intervention occurred over one 16-week semester, which researchers find sufficient to decrease SA and increase SSE in nursing students with mathematics anxiety. The student researcher combined two scales, the Statistics Anxiety Measure (SAM) and the Current Statistics Self-Efficacy (CSSE)/Self-Efficacy to Learn Statistics (SELS) scales so that the Statistics Students Survey (SSS) measured the students' levels of SA and SSE. The students in both groups completed the survey electronically at the beginning of the semester (pre-test measure) and the end of the semester (post-test measure). Moreover, the student investigator used the SAM with the SELS scale as a pre-test measure. As a post-test measure, she combined the SAM scale with the CSSE scale. Then, she analyzed the pre-test and post-test data with DID regression, correlation, and canonical correlation calculation. The student investigator determined that these were the best methods to address the research questions.

Furthermore, the student investigator completed individual interviews with each student from the TBL intervention group to gain more in-depth insight into the intervention implications and outcomes. This approach made the quantitative data comprehensive, which aided in a better understanding of the underlying effects of the intervention. Fifty-nine students received the control curriculum, and 101 students received the intervention curriculum. Seven of the students who received the control curriculum completed the pre-test, and 21 students completed the post-test. Moreover, 21 of the students who received the intervention curriculum completed the pre-test, and 47 students completed the post-test. The student investigator conducted individual interviews with 15 students from the intervention group and examined the data with a thematic analysis approach.

Process Evaluation

Reducing SA among undergraduate nursing students was the intervention's primary objective. The student investigator determined fidelity of implementation of the TBL intervention on five dimensions: program differentiation, adherence, exposure, quality, and responsiveness. The research question was: To what extent did the implementation of the team-based learning intervention to nursing undergraduate students align with the proposed plan?

Program Differentiation

Program differentiation comprised fidelity to the four pillars of TBL (formation of strategic permanent heterogeneous teams, readiness assurance process, team engagement in prescribed activities, and peer evaluation process) and the four TBL pedagogical practices (group and individual accountability, structured discussions, motivational aspects, and feedback cycles).

Adherence

The student investigator collected two forms of data: one was *Yes* or *No*, and the other was a percentage. She marked the number of *Yes* answers and divided them by the eight categories of program differentiation (see Appendix M). The study met adherence to form strategic permanent heterogeneous teams, team engagement in prescribed activities, peer evaluation process, group and individual accountability, structured discussions, motivational aspects, and feedback cycles. Conversely, the study did not meet adherence to the readiness assurance process component of TBL. Therefore, the overall score for adherence was 87.5%.

Exposure

The student investigator measured exposure by counting the number of participants involved in each feature of the intervention and recording the duration of their participation. The control group involved 59 students who received the control curriculum, and the intervention group comprised 101 students who received the TBL curriculum. In both groups, students enrolled in a 3-unit online undergraduate nursing statistics course over a 16-week semester. The instructor exposed all of the students to the entire curriculum and provided them the optimal "dosage" of statistics education.

Quality

The student investigator rated the quality of the group discussions on a Likert-type scale from 1=*no interaction* to 5=*high quality group discussion*. Accordingly, the quality of the intervention group discussions was 4, indicating higher than average. Students used Google Docs and Google Hangouts to meet weekly with each other to discuss group project items. Most students responded to the discussion threads multiple times each week. They held more conversations through group text message threads that the student investigator audited; however, these indicated a bias toward additional communication between team members.

Responsiveness

The self-reported self-other assessment evaluated responsiveness, where students described the contribution they and their teammates had on the group objective. The student investigator expected that the degree of responsiveness would vary from one group to another. She used a Likert-type scale as a tool: 1=*did not contribute at all* to 5=v*ital and valuable level of contribution*. In the intervention group, the students took a self-other team assessment (see Appendix K) and scored the team participation of themselves and their team members. Only one student of the 101 students exposed to the intervention curriculum received a 3 (*OK, but could have contributed more*) for the level of participation. All other students rated themselves and their teammates with a 4 (*active and helpful contribution*) or a 5 (*vital and valuable level of contribution*).

Summary

The student investigator evaluated the intervention process based on intervention adherence, exposure, quality, and responsiveness. The results of the process evaluation indicate that the implementation of the TBL intervention to nursing undergraduate students aligned with the proposed plan. Overall, the instructor delivered the undergraduate nursing statistics intervention in the manner planned.

Outcome Evaluation

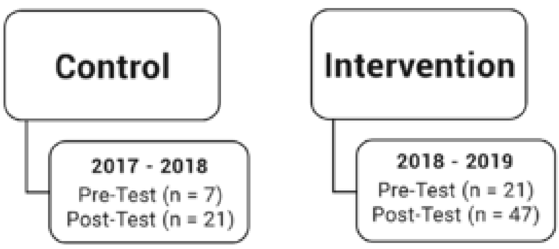
The student investigator accomplished the cross-sectional research with a mixed-methods quasi-experimental research approach, which facilitated the gathering of qualitative and quantitative research. The cross-sectional approach was successful in determining the prevalence of SA and in determining how it related to different variables. The research focused on investigating anxiety levels among nursing students by collecting a variety of data, including demographic data, feelings about the worth of statistics, interpretation anxiety, tests, class anxiety, computational self-concept, fear of asking help, and fear of statistics educators. These variables presented a volume of data that the student investigator analyzed statistically and qualitatively. Furthermore, she triangulated the findings to develop a comprehensive account of the impact of SA among nursing students.

Quantitative Results

A total of 96 students completed the survey, 28 who received the control curriculum, and 68 who received the intervention curriculum (see Figure 5.1**).** The two cohorts were similar in key demographic categories except for race ($p< 0.05$). The majority of students in this sample were female and White (see Table 5.1).

Figure 5.1

Sample Sizes of Pre-Test and Post-Test Surveys for the Control and Intervention Groups



The student investigator summarized crude anxiety and self-efficacy stratified by intervention group and time of testing in **Error! Reference source not found.**. Additionally, she summarized the univariate analyses of the relationship between gender, race, age, and self-efficacy in **Error! Reference source not found.**. Only age had a statistically significant association with self-efficacy (p = 0.01).

Table 5.1

Demographic Characteristics of Participants Who Completed the Statistics Students Survey

Characteristics	Control group (n=28)	Intervention group (n=68)	p-value
Gender (n (%))			
Female	26 (92.9)	60 (88.2)	0.76
Male	2 (7.1)	8 (11.8)	
Race (n (%))			
African American	5 (20.0)	6 (9.0)	0.04*
African American/Hispanic	1 (4.0)	0 (0.0)	
Asian/Pacific Islander	1 (4.0)	15 (22.4)	
White/Native American/Hispanic	1 (4.0)	0 (0.0)	
White	14 (56.0)	31 (46.3)	
Latin American	2 (8.0)	12 (17.9)	
Mexican/Latino	0 (0.0)	1 (1.5)	
Middle Eastern	0 (0.0)	2 (3.0)	
Multi-racial	1 (4.0)	0 (0.0)	
Age (years) (mean[sd])	26.6 (7.8)	25.2 (5.7)	0.33
Age (n (%))			
Adult (age > 25)	11 (40.7)	31 (45.6)	0.84
Traditional (Age 18–24)	16 (59.3)	37 (54.4)	

*significant (p < 0.05)

Shown in Table 5.4 is a summary of the unadjusted analyses. The DID regression analysis identified a statistically significant change (p = 0.04) in SA among students receiving the intervention curriculum compared to students receiving the control curriculum (DID estimate = 50.28). However, the DID regression analysis did not identify a statistically significant change (p = 0.22) in self-efficacy among students who received the intervention curriculum compared to students who received the control curriculum (DID estimate = -11.79). When adjusted for potential confounders including gender, age group (adult, nontraditional student or non-adult traditional student), self-efficacy, or anxiety score at the time of survey completion, it eliminated the association between the outcomes of anxiety and self- efficacy with curriculum ($p = 0.20$ and $p = 0.85$, respectively) with a DID estimate of 26.29 for anxiety and 1-58 for self-efficacy (**Error! Reference source not found.** Table 5.5).

Table 5.2

Crude Results Showing Means and Standard Deviations for Anxiety and Self-Efficacy Scales

Subscales	Control group		Intervention group	
	Pre-test (n=7)	Post-test (n=21)	Pre-test (n=21)	Post-test (n=47)
Anxiety total (mean (sd))	209.57 (60.07)	163.48 (40.32)	170.71 (46.33)	161.28 (50.51)
Anxiety	63.43 (21.69)	51.43 (18.59)	53.10 (20.23)	50.15 (17.81)
Performance	49.86 (10.82)	38.57 (9.71)	36.24 (9.95)	36.17 (10.75)
Attitude class	17.71 (7.52)	12.95 (5.04)	13.38 (6.56)	14.30 (5.26)
Attitude math	48.29 (21.27)	38.52 (17.69)	43.43 (19.25)	35.83 (18.84)
Fearful behavior	30.29 (12.57)	22.00 (9.72)	24.57 (8.86)	24.83 (8.61)
Self-efficacy (mean (sd))	38.57 (14.23)	52.52 (19.69)	41.71 (17.78)	48.98 (18.47)

However, the DID regression analysis did find an association between SSE and SA at the time of the survey. When further controlled for the components of the anxiety subscales, the curriculum was not associated with self-efficacy ($p = 0.51$). Conversely, the student investigator discovered an association between performance score and self-efficacy ($p = 0.00$) (see **Error! Reference source not found.**).

Shown in Tables 5.5 and 5.6 are the confounders added to the primary model (binary variables intervention curriculum and post-test and the continuous variable DID) simultaneously. Also, conventional methods performed adjustments with all the confounders at once. The student investigator determined that a stepwise approach would not change the results of the final analysis. However, she could have performed the stepwise approach to learn how the confounders impacted the variables of interest. Nevertheless, the order of confounder addition impacted the results of this investigation. The order of addition must have, at minimum, a mathematical or bio-theoretical rationale, which is likely beyond the scope of this analysis. For example, should gender be added before the age group? Is gender more significant than the age group? Or is a total self-efficacy score the essential confounder, and should it be added first? Six different orderings of the three confounders of the two adjusted analyses in Table 5.5 provide the same final models. Therefore, a stepwise approach is arbitrary and likely to provide limited value.

Table 5.3

Univariate Analysis Showing Outcomes and Effect Estimates of Anxiety and Self-Efficacy Variables

Model outcome	Variables included in the model	Effect estimate (β)	Standard error (SE)	p-value
Anxiety	Intercept	167.63	5.32	9.99E-52
	Male	-2.73	16.50	0.87
	Intercept	167.67	7.32	1.47E-39
	African American	17.69	16.66	0.29
	Asian/Pacific Islander	-5.92	14.41	0.68
	Latin American	-3.42	14.41	0.81
	Other/missing race	-10.96	20.13	0.59
	Intercept	148.42	6.14	7.62E-42
	Adult age group	42.87	9.24	1.15E-05
Self-efficacy	Intercept	46.31	1.99	7.34E-41
	Male	10.49	6.15	0.09
	Intercept	46.39	2.70	2.39E-30
	African American	-5.21	6.14	0.40
	Asian/Pacific Islander	8.73	5.31	0.10
	Latin American	-3.70	5.31	0.49
	Other/missing race	10.61	7.42	0.16
	Intercept	51.57	2.49	1.46E-36
	Adult age group	-9.61	3.75	0.01

Shown in Table 5.7 is a summary of the Pearson correlation coefficients and power analysis of anxiety to self-efficacy. All subscales of anxiety were inversely associated with self-efficacy, indicating that as anxiety increased, self-efficacy decreased. The student investigator observed a moderate correlation between anxiety and self-efficacy (r = -0.53). Moreover, all analyses confirmed a power greater than 80%.

Table 5.4

Unadjusted Analysis Showing the Results of the Difference-in-Difference Regression for Anxiety and Self-Efficacy Not Adjusted for Potential Confounders

Model outcome	Model variable	Estimate	Standard error	p-value
Anxiety	Intercept	209.57	17.48	2.76E-19
	Intervention curriculum	-46.78	20.45	0.025
	Post-test	-46.10	20.19	0.025
	Difference-in-difference	50.28	24.15	0.041
Self-efficacy	Intercept	38.57	6.83	2.60E-07
	Intervention curriculum	5.32	7.99	0.51
	Post-test	13.95	7.89	0.081
	Difference-in-difference	-11.79	9.43	0.22

Shown in Table 5.8 is a summary of the canonical coefficients of this study. For a 1-unit increase in each of the subscales of anxiety, except performance, there was a 0.01 to 0.04 decrease in self-efficacy. For a 1-unit increase in performance, there was a 0.02 increase in self-efficacy. For a 1-unit increase in self-efficacy, there was a 0.05 increase in anxiety.

The effects of the intervention curriculum on anxiety did not vary by gender, race, or age group, which is shown in the results related to effect modification for SA (see Table 5.9). Furthermore, Table 5.10 shows the results related to the effect modification for SSE. The effects of the intervention curriculum on self-efficacy did not vary by gender or age group. However, the effects of the intervention curriculum on self-efficacy may vary by race. In particular, the degree to which the intervention curriculum increased self-efficacy may be different in African Americans (p = 0.02).

RQ1: In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?

There was a negative association between undergraduate nursing students' SA score and SSE. When the student investigator regressed the anxiety score against self-efficacy, every unit increase in anxiety had a statistically significant decrease in self-efficacy by 0.19 ($p < 0.01$) (see Table 5.5), which is further supported by -0.53 Pearson correlation coefficient between SA and SSE (see Table 5.7).

Table 5.5

Adjusted Analysis Showing the Results of the Difference-in-Difference Regression for Anxiety and Self-Efficacy Adjusted for Confounders Including Age and Gender

Model outcome	Model variable	Estimate	Standard error	p-value
	Intercept	239.44	18.03	9.91E-23
	Male	4.06	13.58	0.77
	Adult age group	32.08	8.46	0.00
Anxiety	Total self-efficacy score	-1.146	0.24	4.77E-06
	Intervention curriculum	-34.87	17.08	0.04
	Post-test	-29.09	17.49	0.10
	Difference-in-difference	26.29	20.19	0.20
	Intercept	76.94	9.54	3.36E-12
	Male	10.49	5.35	0.05
	Adult age group	-2.26	3.67	0.54
Self-efficacy	Total anxiety score	-0.19	0.04	4.77E-06
	Intervention curriculum	-3.07	7.03	0.66
	Post-test	6.12	7.12	0.39
	Difference-in-difference	-1.58	8.20	0.85

RQ2: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics anxiety?

The TBL intervention decreased undergraduate nursing students' SA by 46.78 (see Table 5.4). After adjusting for confounders, the TBL intervention decreased undergraduate nursing students' SA by only 34.87 (see Table 5.5).

RQ2A: To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?

The effects of the intervention curriculum on anxiety did not vary by gender, race, or age group (see Table 5.10).

RQ3: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?

Table 5.6

Cross-Sectional Association Demonstrating the Relationship Between Statistics Self-Efficacy and Statistics Anxiety at the Time of the Survey

Model outcome	Model variable	Estimate	Standard error	p-value
	Intercept	82.96	10.24	3.82E-12
	Male	14.27	5.58	0.01
	Adult age group	-4.70	4.16	0.26
	Anxiety sub-score	-0.28	0.16	0.09
	Performance score	-0.56	0.18	0.00
Self-efficacy	Attitude score	0.58	0.40	0.15
	Attitude in math score	-0.12	0.11	0.27
	Fearful behavior score	-0.10	0.24	0.68
	Intervention curriculum	-4.70	7.10	0.51
	Post-test	6.26	7.11	0.38
	Difference-in-difference	-2.55	8.46	0.76

Qualitative Results

The student investigator interviewed 15 of the 101 students who received the intervention curriculum. She asked the interviewees for their first-hand accounts and impressions of the TBL initiatives in the statistics course. All of the students interviewed came from the intervention group. Four of the respondents were male, and 11 were female (see Table 5.15). Themes emerged from the data that aligned with the research questions.

Qualitative Analysis of Intervention Group

The purpose of this analysis is to present the narrative research findings. The student investigator interviewed 15 nursing students enrolled in a statistics course concerning their first-hand accounts and impressions of the TBL initiatives. Themes evolved from the analysis of the study's three research questions:

RQ1: In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?

RQ2: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics anxiety?

RQ2A: To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?

RQ3: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?

RQ3A: To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students?

Table 5.7

Correlation (Pearson) Between Anxiety Subscales with Self-Efficacy and Power Analysis

Subscales	Self-efficacy	Power
Anxiety total	-0.53	1.00
Anxiety	-0.49	1.00
Performance	-0.44	1.00
Attitude class	-0.29	0.82
Attitude math	-0.35	0.95
Fearful behavior	-0.41	0.99

Themes

Qualitative Results by Research Question.

RQ1: In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?

Overall, SA is inversely related to self-efficacy. When students expressed anxiety about statistics—whether it was exams, quizzes, the final assessment, or activities in the course—they showed a lack of confidence. Students' responses conveyed that their anxiety stems from several confidence-related factors, the first being a lack of understanding. Statistics is a course in which students are required to complete mathematical equations and then must interpret those results to make conclusions.

Therefore, SA can exist within the mathematical content as well as using and applying those results. Students felt SA when they thought they did not understand the course material. For example, Participant E stated, “The exams were tough, and you had to really master the subject to get a passing score.” Students also felt anxious because of self-doubt when performing math problems and interpreting the answers. Participant N said, “I was anxious about my way of interpreting answers.” This response indicates that the use of the material and the general understanding behind the principles resulted in a lack of confidence and an increase in SA.

Table 5.8

Canonical Coefficients Between Anxiety Subscales and Self-Efficacy

Subscales	Self-efficacy
Anxiety	-0.03
Performance	-0.04
Attitude class	0.02
Attitude math	-0.01
Fearful behavior	-0.01
	Anxiety
Self-efficacy	0.05

Students who expressed confidence in statistics and performing individually in the course expressed higher levels of self-efficacy. Moreover, students who were confident during exams and quizzes attributed their confidence to faith in their abilities. Participant H went so far as to say, “[I was] pretty confident. I knew I wasn’t going to understand everything right away, but with practice, I would.” As a result, when a student felt high levels of SSE, there were lower levels of SA attributed to graded assessments.

RQ2: To what extent does a team-based learning intervention affect undergraduate nursing students’ statistics anxiety?

Overall, TBL intervention decreased SA. While many students did not speak directly to how the TBL intervention affected their anxiety, some students did express that the TBL activities helped to decrease their anxiety and made the course more enjoyable. For example, Participant K stated, “I think it was a great learning experience because interpretations were necessary and seeing different interpretations from different people eased anxiety.” Fewer students expressed anxiety completing the group’s final assessment than with regular exams and quizzes. Therefore, incorporating TBL activities decreased SA for some of the participants.

Table 5.9

Effect Modification for Anxiety Adjusting for Age, Ethnicity, and Gender

Model outcome	Model variable	Estimate	Standard error	p-value
	Intercept	201.76	18.82	9.26E-18
	Intervention curriculum	-30.20	21.55	0.16
	Post-test	-40.89	21.20	0.057
	Male	54.68	35.64	0.13
	Difference-in-difference	33.25	24.72	0.18
	Intervention curriculum*male	-72.43	40.04	0.07
	Intercept	196.34	22.36	1.64E-13
	Intervention curriculum	-21.97	25.50	0.39
	Post-test	-40.68	22.97	0.08
	African American	34.00	25.48	0.19
	Asian/Pacific Islander	-6.66	51.18	0.90
	Latin American	28.22	33.00	0.39
	Other/missing race	2.17	27.79	0.94
Anxiety	Difference-in-difference	33.20	26.45	0.21
	Intervention curriculum*African American	-28.39	33.67	0.40
	Intervention curriculum*Asian/Pacific Islander	0.38	53.49	0.99
	Intervention curriculum*Latin American	-43.95	36.81	0.24
	Intervention curriculum*other/missing race	-27.39	41.04	0.51
	Intercept	194.57	18.07	8.37E-18
	Intervention curriculum	-43.84	20.93	0.04
	Post-test	-45.17	19.19	0.02
	Adult age group	35.01	17.12	0.04
	Difference-in- difference	33.89	22.36	0.13
	Intervention curriculum*adult age group	11.62	20.15	0.575

*interaction

RQ2A: To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?

It was challenging to produce qualitative data on this research question because the student investigator did not ask participants questions directly about the influence of age, gender, or race on SA. Participants had no response to discussions about the impact of their demographic variables on their confidence in the statistics course, making it impossible to produce sample responses. Therefore, the student investigator analyzed the feelings of confidence attributed to SA within the participant interview responses and tabulated them using the demographic variables to address this research question. Table 5.11 shows the demographic characteristics of people enrolled in the study. That table is then broken down into the degrees of SA as reported by ethnicity in Table 5.12, age in Table 5.13, and gender in Table 5.14. These results are debriefed in more detail within the discussion section.

Only Latin American participants and those choosing not to provide information about their race expressed anxiety when taking the final assessment, exams, and quizzes. Participants in each race category were anxious about taking exams and quizzes than the final assessment, except the Latin American participants. However, an equal number of Latin American participants were anxious about the final assessment as well as taking exams and quizzes (n=1. Only Asian/Pacific Islanders, N/A, and Latin American participants expressed decreased anxiety from the TBL intervention.

The participants in all age groups were more anxious about the exams and quizzes than the final assessment. None of the participants aged 26–30, felt anxiety about the final assessment. More 20 to 25–year-old participants expressed decreased anxiety from the TBL intervention than other age groups. As a result, there may be age-related differences in participant SA levels.

Both genders had more participants show anxiety over exams and quizzes than the final assessment, providing further evidence that graded assessments and assignments induce higher levels of SA. Nevertheless, only females expressed anxiety about the final assessment and decreased anxiety from the TBL interventions. Therefore, there may be gender-related differences attributed to different levels of SA as experienced by these participants.

Table 5.10

Effect Modification of Self-Efficacy Adjusting for Age, Ethnicity, and Gender

Model outcome	Model variable	Estimate	Standard error	p-value
Self-efficacy	Intercept	38.97	7.12	3.93E-07
	Intervention curriculum	2.07	8.15	0.80
	Post-test	13.68	8.02	0.091
	Male	-2.82	13.48	0.835
	Difference-in-difference	-7.85	9.35	0.40
	Intervention curriculum*male	16.92	15.14	0.27
	Intercept	44.04	8.09	5.02E-07
	Intervention curriculum	-5.46	9.22	0.56
	Post-test	12.70	8.31	0.13
	African American	-22.60	9.22	0.02
	Asian/Pacific Islander	-5.74	18.51	0.76
	Latin American	-10.94	11.93	0.36
	Other/missing race	6.18	10.05	0.54
	Difference-in-Difference	-6.44	9.57	0.50
	Intervention curriculum*African American	29.02	12.18	0.02
	Intervention curriculum*Asian/ Pacific Islander	17.98	19.34	0.36
	Intervention curriculum*Latin American	11.96	13.31	0.37
	Intervention curriculum*other/missing race	2.32	14.84	0.88
	Intercept	43.80	7.43	6.62E-08
	Intervention curriculum	1.63	8.61	0.85
	Post-test	13.43	7.89	0.09
	Adult age group	-12.21	7.04	0.09
	Difference-in-difference	-5.82	9.20	0.53
	Intervention curriculum*adult age group	3.54	8.29	0.67

*interaction

There are no quotes to support this research question because no participants specifically mentioned age, gender, or race, contributing to their self-efficacy or anxiety. However, the tables help to demonstrate the effect of anxiety attributed to age, gender, and race. In the discussion section, the results from participant interview responses are combined with those from the quantitative section to identify more effectively the effect of race, gender, and age on SA.

Table 5.11

Demographic Characteristics of Participants Enrolled in the Study

Participant ID	Semester and year enrolled in undergraduate statistics	Gender	Ethnicity	Age (years)
A	Spring 2018	Male	N/A	N/A
B	Spring 2018	Female	N/A	N/A
C	Summer 2018	Female	N/A	N/A
D	Fall 2018	Female	N/A	N/A
E	Fall 2018	Female	Asian/Pacific Islander	31
F	Spring 2018	Female	White	20
G	Fall 2018	Female	Middle Eastern	23
H	Fall 2018	Male	Asian/Pacific Islander	29
I	Fall 2018	Male	N/A	35
J	Fall 2018	Female	Latin American	24
K	Spring 2018	Female	Asian/Pacific Islander	23
L	Fall 2018	Female	White	24
M	Fall 2018	Male	White	28
N	Fall 2018	Female	Latin American	25
O	Fall 2018	Female	Middle Eastern	24

Note: A total of 15 students (68.7% females, mean=26, SD=4.31 years) belonging to various ethnic groups provided the qualitative data.

RQ3: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?

Overall, TBL increased self-efficacy. Eleven of 15 students in the intervention group felt confident during the course. Moreover, some students expressed that their confidence grew as they advanced through the course and worked on TBL activities. For instance, Participant E reported, “I did not feel confident at first, but due to the structure of this course, it helped me to become a little more confident as the course progressed.” Therefore, some students who began the course feeling high levels of SA experienced a decrease in SA by going through the course activities. Participant J reported gaining confidence over the course of the class, “The final project utilized all of the material we had learned in class and was broken down over the span of the semester. I think going through all of the steps for a small research study also increased my confidence level because I understood the entire process and knew why we were choosing a specific function in SPSS.”

Table 5.12

Degree of Statistics Anxiety Expressed by Study Participants Among Different Ethnic Groups

Anxiety	Ethnic groups					
	Asian/ Pacific Islander (n=3)	White (n=3)	Middle Eastern (n=2)	Not available (n=5)	Latin American (n=2)	Total (n=15)
Anxious about final assessment	0	0	0	2	1	3
Anxious taking exams and quizzes	2	2	1	4	1	10
Decreased anxiety	1	0	0	1	1	3

Most of the students found that the TBL initiatives of the course were helpful and preferred to work as a team rather than on their own. They shared that the most beneficial part of TBL was the multiple points of view that working with a group brought to the project. Participant E discussed the benefits of TBL, “With statistics problems, being part of a team helps because there are other ideas from other team members that can help solve problems that you might not understand.” Overall, TBL facilitated collaboration amongst the students, allowing them to contribute their strengths to the group and create a bank of shared knowledge. Group work assignments allowed individuals to learn from their peers and to see new strategies to solve problems outside of what the instructor taught. Participant H stated that TBL was beneficial because of “getting info from different people to reach different conclusions.” The students also mentioned that multiple points of view and collaboration resulted in less room for error.

Table 5.13

Degree of Statistics Anxiety Expressed by Different Age Groups of Study Participants

Anxiety	Age groups			
	20–25 yrs. (n=7)	26–30 yrs. (n=4)	Not Available (n=4)	Total (n=15)
Anxious about the final assessment	1	0	2	3
Anxious taking exams and quizzes	4	3	3	10
Decreased anxiety	2	0	1	3

Consequently, they used each other as safety nets, relying on their teammates if they did not understand a concept or made a mistake in calculation. When asked whether the student would prefer to work individually or in a team, Participant J stated, “[In a] team, because sometimes I think I know the answer, and I find out that I've missed a step or misread the question.” Therefore, TBL may have helped with SA as group assignments utilized concepts that students had learned in class and applied to a real-world example, resulting in the students feeling more confident in their abilities to use these skills in the future. The students could collaborate and share their knowledge to improve their overall understanding of the subject by working in teams.

The students also felt that the group assignments allowed for guided practice and gave them opportunities to ask questions, resulting in more confidence when they completed their homework. Participant L appreciated the group assignments and stated, “I liked the in-class work because it provided an opportunity for guided practice, making homework a little easier to do, knowing that we did exercises in class. The in-class work increased my homework confidence.” Group assignments also increased their confidence in using statistics in subsequent careers. Participant J stated that “The final group project made me feel like I could use statistics in the workplace and confidently figure out how to apply them to public health." More participants also expressed confidence in performing the final group assessment than tests, quizzes, or independent work. Participant D expressed confidence through group work, "The final project increased my confidence in stats. I feel like I benefitted from working with the group, and I was able to learn from my peers."

Table 5.14

Degree of Statistics Anxiety Expressed by Male and Female Study Participants

Anxiety	Male (n=4)	Female (n=11)	Total (n=15)
about the final assessment	0	3	3
taking exams and quizzes	2	8	10
;ed anxiety	0	3	3

A secondary finding was that TBL could cause a decrease in self-efficacy through group members not contributing equally. For example, two students felt that TBL was not helpful to their and others' overall success in the course. These students highlighted that relying on others and collaborating on TBL activities might lead to social loafing. Participant I expressed their disdain for group work, "Group work encourages mediocre academic achievement. Students should have the confidence to address problems in the field post-education and not assume that someone else or a group of other individuals will be able or willing to assist them doing their work." The same participant felt that the TBL intervention hindered their ability to learn in the course stating, "I would have learned more if I did the project myself. I should have been allowed to struggle independently, even if this means receiving a lower grade."

This sentiment implied that when other members did not work as hard, it led to disadvantages, such as those members not learning as much as the others. It also led to some members of the group taking on extra work. Participant B expressed, "[Some of the] disadvantages were the division of work. Some members of the group repeatedly did not contribute, causing others to take on greater amounts of the project." Therefore, some students did not see group work as an advantage and would have preferred to work independently. The students suggested improvements to the course's TBL to improve the group work experience. Some felt that TBL could be integrated into the course, using TBL interventions during lectures. Participant L stated, "Include [TBL] practice in class, and offer help during that time." Participant J echoed this sentiment, "Continue to utilize in-class group time to work on activities."

Others thought that the arrangement of the groups needed to change—additionally, the students who preferred to work independently provided ideas about how group work could improve. Suggestions included not to create groups randomly and, instead, comprise them of two members instead of three. For example, Participant J suggested, "Maybe making it a partnership instead of a group. Have two people in a group, instead of three." These changes could ensure more accountability amongst the group members and potentially reduce the social loafing effect. Participant I recommended to "structure teams as follows: (a) not randomized (teams should be constructed based on the individual's strengths), and (b) assign a team leader and make 10% of this person's grade unique to the success of the class."

Overall, there were more positive than negative reactions toward TBL and how it improved SSE. However, there were some students who would have preferred to work independently and did not find TBL beneficial. Some students did not like how the instructor used TBL within the course, but provided suggestions on how the instructor could utilize TBL in an improved format. (See Table 15 for select interview questions and interesting responses that were repeated during the course of the interviews.)

RQ3A: To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students?

Because the student investigator did not ask interview questions about the influence of the age, gender, or race on SSE, it was challenging to produce qualitative data on this research question. Moreover, participants did not respond to discussions concerning the impact of their demographic variables on their confidence in the statistics course, making it impossible to produce sample responses. Therefore, to address this research question, the student investigator analyzed feelings of confidence attributed to SSE within the participant interview responses and tabulated them by the demographic variables. The degree of SSE is reported by ethnicity in Table 5.16, age in Table 5.17, and gender in Table 5.18. Moreover, this data is debriefed in more detail within the discussion section.

As a result, there may be differences in SSE between students of different ethnicities. More students in each age group were more confident than not during the course (see Table 5.16). Most of those who felt confident were between the ages of 20–25. Those students who refrained from sharing their age were the least confident of any other age group. More 20 to 25-year-olds (n=3) were confident with the final assessment than other age groups; however, an equal number of 20 to 25-year-olds (n=3) were confident about the final assessment and performing work independently. More 20 to 25-year-olds felt TBL activities increased their confidence. More 20 to 25-year-olds and 26 to 30-year-olds (n=5) preferred to work as a team than on their own. More 20 to 25-year-olds (n=5; 71%) preferred working as a team.

However, a higher percentage of 26 to 30-year-olds (n=3; 75%) preferred working as a team. Therefore, there may be differences in levels of SSE between students of different age ranges. More females (n=9) than males (n=2) expressed confidence in the course, while more males (n=2) than females (n=1) reported they were not confident (Table 5.17). An equal number of male participants expressed confidence (n=2) and no confidence (n=2) during the course. More females expressed confidence (n=9) than no confidence (n=1) during the course. Only females expressed confidence about the final assessment (n=5) or doing independent work (n=4), while no males reported confidence about the final assessment (n=0) or working independently (n=0).

Descriptive Insights

Table 5.15

Interview Questions and Sample Responses from Interviews

Interview question	Sample response
1. Why did you enroll in this course?	Participant J: This course was required for my program.
2. What do you attribute to you staying enrolled in this course?	Participant E: It is required to graduate.
3. What are your perceptions of team-based learning within the context of the nursing statistics course?	Participant O: Teamwork is better because of the different perspectives and understandings.
4. Can you think of any examples of specific advantages or disadvantages of working on in-class projects as part of a problem-solving team in the nursing statistics course?	Participant C: It was difficult and frustrating when someone on the team did not do their part. It was good in a sense, because you had help from other classmates.
a. What about that was advantageous, or why do you think that was disadvantageous?	Participant C: Disadvantage is that someone had to pick up the slack or run the risk of receiving a lower grade. Advantage is having someone to bounce ideas off of and double-check your work.
5. If you had a choice between working on statistics problems individually or as part of a team, which would you choose? Why?	Participant M: Team—Someone may notice something I have missed, if I get stuck (or vice versa)
6. How confident did you feel during this course?	Participant J: Initially, I felt very confident, but p-values changed that quickly. I think I left the class feeling more excited than confident about the material.
7. Which activities did you like the most, and during which activities did you feel most confident?	Participant G: I liked the class/group activities after a lecture because it gave us time to practice what we just learned by ourselves and with a group.
8. Were there any activities or assessments where you felt less sure of yourself?	Participant L: Some in-class assignments aligned with the homework for the week; however, some did not. Those weeks made me feel less sure of myself and what I knew.
9. How did you feel when taking exams in the statistics course?	Participant B: I felt slightly anxious. I very much disliked the testing software program.

Table 5.15 (cont.)

Interview Questions and Sample Responses from Interviews

Interview question	Sample response
10. How did you feel when taking quizzes (Spring course) or working on projects in the statistics course?	Participant L: Very anxious; under-confident; did not know what exactly to expect.
11. How did you feel about the final assessment in the statistics course?	Participant L: The final project increased my confidence in stats. I feel like I benefitted from working with a group, and I was able to learn from my peers. -
12. Why do you think those activities affected you positively or negatively?	Participant K: It was difficult to work with people who did not stay on task and did not seem like they were as invested in the class as other group members. -
13. What about those experiences did you like (or did not like)?	Participant C: I felt like an imbecile with each quiz and assignment. -
14. What might you change about the activities, if you had a chance to do it over again?	Participant H: Maybe making it a partnership instead of a group.
15. What would you recommend to an instructor who might be teaching this course, specifically for students who might feel the same way about the activities as you felt?	Participant N: Overall, just guidance. I did not lack guidance and feedback in the past, but I overall need more than maybe other students.
16. How do you think you might use the content from this course in your personal or professional contexts?	Participant O:I think that in the public health field, having a basic understanding of statistics will always help you. Understanding how to read journal articles or how to conduct research at your job will all come from the things learned in statistics.

Note: This table highlights memorable moments that occurred during the interviews, many of which reoccurred

Mixed-Methods Conclusions

Statistics is a course that induces anxiety in undergraduate nursing students. However, the introduction of TBL into the curriculum has a favorable effect on the student learning process, interest in statistics, and reduction of anxiety. When asked about their preference between individual learning or TBL, the majority of participants responded that they preferred TBL.

When probed further about their perceptions of TBL, nearly half of the participants reported positive experiences with TBL. Furthermore, when the student investigator asked the participants about the activities they enjoyed in the statistics course, almost half stated they preferred group activities, group projects, and class discussions.

These results are confirmed by the quantitative research, indicating that the intervention group had lower levels of anxiety compared to the control group. The DID analysis identified a statistically significant change in anxiety among students who received the intervention curriculum compared to those who received the control curriculum. Moreover, the DID analysis uncovered an association between performance score and self-efficacy. Therefore, triangulation between the quantitative and qualitative results provide evidence of the benefits of TBL to decrease SA in students taking undergraduate nursing statistics courses.

Table 5.16

Degree of Self-Efficacy Expressed by Study Participants Among Different Ethnic Groups

	Ethnic groups					
	Asian/ Pacific Islander (n=3)	White (n=3)	Middle Eastern (n=2)	Not available (n=5)	Latin American (n=2)	Total (n=15)
Confidence during course	3	3	2	2	1	11
Not confident during course	0	0	0	3	0	3
Confident about final assessment	1	1	1	1	1	5
Confident doing independent work	1	1	1	1	0	4
Confident with exams and quizzes	1	1	1	1	0	4
TBL activities increased confidence	3	3	2	2	2	12
Work as a team	3	2	2	2	1	10
Work individually	0	1	0	3	0	4
TBL can cause social loafing	2	1	0	3	1	7

Discussion

In nursing education, it is imperative that students are adept at developing statistical and numerical skills. These skills can improve the students' drug calculation abilities, increase their confidence in giving the correct medication dosage to patients, and encourage them to take part in evidence-based practice by conducting research. Moreover, nurses are usually involved in clinical trials as a part of research teams and participate in various stages of medical research. Being a part of a research team requires not only readiness to assist in diverse team-based activities, but also statistical literacy.

Table 5.17

Degree of Self-Efficacy Expressed by Different Age Groups of Study Participants

	Age groups			
	20–25 yrs. (n=7)	26–30 yrs. (n=4)	Not available (n=4)	Total (n=15)
Confidence during course	6	3	2	11
Not confident during course	0	1	2	3
Confident about final assessment	3	1	1	5
Confident doing independent work	3	0	1	5
Confident with exams and quizzes	2	1	1	4
TBL activities increased confidence	7	3	2	12
Work as a team	5	3	2	10

However, the high degree of SA related to statistics class content may lead to students dropping out of the class or the program. The literature review demonstrated the connection between anxiety and self-efficacy in learning statistics. Moreover, the literature review findings indicated that these variables are related and that both influence student achievement (Chiou et al., 2014; Macher, Paechter, Papousek, & Ruggeri. 2012; McGrath et al., 2015; Perepiczka et al., 2011). As a result, educators should identify teaching strategies that enhance students' self-efficacy and decrease their levels of anxiety related to the course material.

Discussion by Research Question

RQ1: In what way(s) do(es) nursing students' statistics anxiety relate to their statistics self-efficacy?

The student investigator addressed this research question using correlation coefficients from the canonical analysis. All subscales of anxiety were negatively associated with self-efficacy, indicating that as SA increases, SSE decreases. This result supports previous findings by Perepizka et al. (2011) and Younesi et al. (2014). The literature also showed that SA is negatively related to overall performance in statistics courses (Lyons & Beilock, 2012; Zeidner, 1991). Similarly, Finney and Schraw (2003) found that self-efficacy is related to performance and that students with higher levels of SSE are successful in solving statistics problems. In the current study, high scores in statistical self-efficacy were correlated with low SA. Consequently, both variables are strictly related to performance in statistics.

Table 5.18

Degree of Self-Efficacy Expressed by Male And Female Study Participants

	Male (n=4)	Female (n=11)	Total (n=15)
Confidence during course	2	9	11
Not confident during course	2	1	3
Confident about final assessment	0	5	5
Confident doing independent work	0	4	4
Confident with exams and quizzes	1	3	4
TBL activities increased confidence	2	10	12
Work as a team	3	7	10
Work individually	1	3	4
TBL can cause social loafing	1	6	7

The outcomes of this study are explained by applying the principles of Bandura's (1977) social cognitive theory. According to this theory, self-efficacy is a critical factor in a human being's self-regulation and competencies. It represents the extent to which people believe in their abilities, and it is significantly related to past experiences and emotional states. Therefore, people may interpret the high emotional arousal that occurs in situations of anxiety, tension, and stress as signals that they are about to perform poorly. This feeling can inhibit the subject's potential and lead to the phenomenon known as a self-fulfilling prophecy (e.g., the interpretation of beliefs and feelings concerning a person's capacity may determine their progress). If a person believes they are not good at statistics, it is expected that they will feel anxious about learning statistics, completing exercises, and taking tests, which can lead to poor performance.

According to Knowles (1980), self-direction is emphasized in adult learning; and, learners are responsible for their education. This assumption emphasizes the importance of self-efficacy to learn statistics. By taking responsibility for their education in statistics, students lacking confidence in their statistical abilities may feel less anxious regarding their knowledge.

The nature of the relationship between SSE and SA is further explained with qualitative data. The students who participated in the interviews reported that a lack of understanding of the material could cause anxiety. The self-doubt in interpreting answers was also the reason why a subset of the students felt anxious. The student investigator's interpretation of these common themes that emerged from the interviews suggests that SA is inversely related to SSE. A lack of understanding of the material and self-doubt is a confidence-related factor that is a sign of low SSE, making the students feel anxious about tests, exams, and quizzes. Moreover, the interviews with students provided evidence that regardless of their confidence level, most students experience anxiety related to tests and quizzes. The exams create situations of high emotional arousal for students, which is one of the factors that influence self-efficacy, according to Bandura's (1977) social cognitive theory. Therefore, in these stressful situations, the self-efficacy level can decrease when students lack confidence in their capabilities, which further affects the SA level. Moreover, the lack of statistical self-efficacy can discourage participation in other curricular activities, such as discussions, projects, and learning, leading to more unsatisfactory performance. In general, SA is a construct consisting of multiple dimensions, not only exam-related anxiety; therefore, the relationship between SA and SSE can be revealed on other occasions as well.

RQ2: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics anxiety?

The student investigator used a DID regression analysis to address this research question. The results indicate a statistically significant change in anxiety among students who received the intervention curriculum compared to students who received the control curriculum ($p<0.05$). According to the results, the students who learned in teams and completed the group project reported a more significant change in the SA level. This finding is consistent with the research of Kinkead et al. (2016), which identified that working collaboratively reduced anxiety levels in adults, encouraging participant's productivity. Individuals might be less tense and anxious regarding their statistical knowledge, exams, and projects when collaborating with peers because responsibility-sharing can decrease anxiety. That is, individuals in teams are less afraid of making a mistake because of the impact of mutual accountability.

The support that students receive from team members can also serve as a stress-buffer and reduce anxiety levels. This assumption is confirmed by research conducted by Perepiczka et al. (2011), which found a relationship between social support, SA, and SSE. Furthermore, the ZPD concept, developed by Vygotsky (1978), explains peer-mediated learning. As the students learn together, they create a new learning context where meaning-making of the course content is happening as their ZPDs emerge (Havnes, 2008). In this context, students would feel less anxious in comparison to the context where scaffolding is facilitated by a dominant person on a higher level of the hierarchy.

The qualitative data triangulated the current study's findings. The interviews with the students demonstrated that the majority of participants thought that the TBL course helped them decrease their anxiety. When students learned together, the expectation was that group collaboration would lead to lower individual anxiety levels. However, the results of the DID regression analysis showed that the TBL intervention had a significant effect on the students' SA levels in the cases where the DID regression analysis was unadjusted to the confounders. These included gender, age, self-efficacy, or the anxiety score at the time of survey completion.

Therefore, it is possible that interfering factors other than the intervention influenced the change in the level of SA. The changes in SA may be a result of other factors that were not closely related to the intervention, such as general anxiety/self-efficacy at the moment the survey was completed, as well as personal traits. For example, the change in the SA could be a result of the evolving self-efficacy that the students achieved over time as they learned about statistics.

RQ2A: To what degree do age, gender, and race influence the effect of the intervention on statistics anxiety in undergraduate nursing students?

The results of the effect modification for SA showed that the effects of the intervention curriculum on anxiety did not vary by gender, race, or age group. However, according to the qualitative analysis of the participant's responses, the age of the participants could be one of the factors responsible for the change in the SA level over time. For instance, young students unfamiliar with college assignments are likely to feel anxious because they do not know what to expect. As the analysis of the interviews showed, none of the participants aged 26 to 30, felt anxiety about the final assessment, while more 20 to 25–year-olds expressed decreased anxiety from the TBL intervention than other age groups. Younger students may adjust better with the help of TBL. According to Knowles (1980), the essential component of helping adults learn is a climate of physical comfort, mutual trust, respect, and openness, as well as the acceptance of differences. A learning environment that provides support and acceptance is significant to a student's adjustment to courses and college itself. Learning in a team can make young students feel accepted and appreciated, which can facilitate the studying process and reduce their anxiety level.

Additionally, gender may contribute to levels of SA, as research indicates that females tend to experience significantly higher levels of SA (Vahedi, Farrokhi, & Bevrani, 2011). According to Bui and Alfaro (2011), SA may manifest differently in males compared to females; thus, individuals of different genders may have a different response to TBL. Although effect modification analysis did not show any significant effect of gender in this study's sample of the students who participated in interviews, only females expressed decreased anxiety from TBL interventions. Furthermore, female students were more anxious than male students about the final assessment. It is possible that female students were more willing than males to share their worries and vulnerabilities with other people; thus, having additional benefits from the support that they received from other team members. As Reevy and Maslach (2010) argued, female qualities are linked with a better ability to provide, seek, and receive emotional support. Traditional male roles may lead to expectations that males should always seem confident, self-assured, and independent due to their different socialization experiences (Barbee et al., 1993; Day & Livingstone, 2003). These assumed gender roles could be the reason male students were less ready to share their exam-related anxieties with their peers or even with the interviewer.

As for the effect of race, the Latin American participants and participants choosing not to provide their racial identity, expressed anxiety in the final assessment and taking exams and quizzes. The responses of other participants indicate that they were anxious about exams and quizzes only. The students who talked about the benefits of TBL to decrease anxiety did not share their race or identified themselves as Asian/Pacific Islanders or Latin American. This response may indicate that minorities have a better response to TBL. However, since there was a small, disproportionate sample of diverse students who participated in the interviews, this suggestion may not be generalizable, and additional research may be required to determine how minority students react to TBL.

RQ3: To what extent does a team-based learning intervention affect undergraduate nursing students' statistics self-efficacy?

While the TBL intervention increased undergraduate nursing students' self-efficacy by 7.48, the DID regression analysis (see Table 5.6) did not identify a statistically significant change in self-efficacy among students who received the intervention curriculum compared to students who received the control curriculum ($p>0.05$). This outcome suggests that the change in self-efficacy that students reported was not significantly related to the teaching approach. It is possible that other factors influenced statistical self-efficacy in students. A study conducted by Macke and Tapp (2012) found a link between TBL and self-efficacy; however, the current study did not confirm those results. This discrepancy may be a result of different analyses used in the two studies and different populations of students. While Macke and Tapp examined the effects of a TBL intervention in graduate social work degree students, the current study sampled undergraduate nursing students. Moreover, the student investigator discovered an association between performance score and self-efficacy ($p<0.05$) (see 5.7), a finding that indicates that these two variables are closely related and that the change in self-efficacy may be a result of the exposure to the curriculum than of the teaching approach.

As Bandura (1995) claimed, self-efficacy is based on past experiences. Past failures or successes in other statistics or mathematics-oriented courses would be influential in a student's self-efficacy toward a statistics course. As apparent from the results, the opinions and beliefs about statistical competencies that an individual formed over an extended period cannot be easily changed with a single educational intervention. This hypothesis highlights the significance of implementing various and diverse teaching strategies directed at enhancing student's self-efficacy. It would be of value if these interventions were applied continuously and at various points in an individual's education. Although the quantitative data demonstrates that the intervention did not have a significant effect, some students expressed that their confidence grew as they went through the course and worked on TBL activities and that they identified many advantages of the intervention.

Further, the thematic analysis of qualitative data provides some explanations for the quantitative results because the interviewed students expressed mixed opinions on TBL intervention and its relationship with their self-efficiency. While the majority of students had positive views about this form of learning and liked the group project, some of them had different perceptions and preferred individual learning. The students were more anxious and nervous concerning tests, exams, and quizzes. In the context of the DID regression analysis results, this may indicate that students' SA related to testing of their knowledge is not easily affected by the teaching approach. One caveat of TBL is that members have to rely on each other, which may lead to unfair work distribution. The effect of social loafing was identified as the most significant disadvantage of using TBL intervention.

RQ 3A: To what degree do age, gender, and race influence the effect of the intervention on statistics self-efficacy in undergraduate nursing students?

According to the results, the extent to which the intervention curriculum increased SSE was statistically significant in African American students, but not in White, Asian/Pacific Islander, Latin American, or those reporting their race as other (see Table 5.12). This outcome suggests that African American learners can benefit from applying team-based learning strategies. Similarly, Snyder et al. (2016) found that team-based activities are considerably helpful in minority students' performance. The reason behind this could lie in the assumption that a critical characteristic of African American racial identity is collectivism (Carson, 2009). Thus, these African American students may have felt more comfortable when working in a team than non-minority students who possibly felt more secure and confident when learning individually. The responses that students provided in the interview demonstrate that the participants in each of the racial groups, except the ones who did not identify themselves as a part of any racial group, believed that TBL activities gave them the most confidence. Therefore, regardless of their racial identities, students can obtain certain benefits from TBL, though the mechanisms through which these benefits are gained could be different.

The effects of the intervention curriculum on self-efficacy did not vary by gender or age group, according to the effect modification analysis and the data received in the interviews. Students of all age groups and both genders were equally confident in the course, and the majority of the participants had similar opinions on how TBL affected their self-efficacy.

Overall, the findings of the current study indicate that individuals react to TBL differently and experience the various advantages (and some disadvantages) of the intervention, suggesting that there is a need to research this topic further. Additionally, the findings emphasized the active role of the students and urged a constructivist approach in interpreting the results. According to Bandura's (1986) social cognitive theory, people learn new behaviors observationally through modeling (which is observing other people [models]).

Therefore, human behavior depends on other participants in the environment as well as the individual's state of mind. By applying this postulation to the context of the academic practice of making successful educational interventions, it is essential to consider the student's current state of mind within the learning community environment where a student feels safe. In this environment, students need to focus their attention on appropriate models, which must be meaningful to them so the student will want to emulate the behavior leading to mastering the aimed curriculum. As Bandura (1994) claimed, one of the ways people create and strengthen self-efficacy beliefs is through the vicarious experiences provided by social models; namely, by seeing people perceived as similar to themselves master the given task, people can internalize the belief that they are capable of doing it successfully as well. In the usage of TBL in the classroom, meaningful models can be team members who would facilitate each other's progress. The impact of modeling on perceived self-efficacy is influenced by perceived similarity to the models

(Bandura, 1994). Therefore, if students see the models in a team as similar to themselves, this will help them to acquire a greater sense of self-efficacy.

It is especially crucial for the students' ZPD in TBL. The students who work in a team create new learning contexts through peer-mediated learning where their ZPDs emerge, allowing them to use different learning strategies, offer diverse solutions, and express conflicting opinions (Havnes, 2008). However, if the collaboration does not occur within the student's ZPD, it can be expected that the individual will not benefit from a TBL-based intervention. That is why the process of building successful teams with compatible members is significant.

Reflecting on Power, Effect Size, and Sample Size

A study conducted by Carpenter et al. (2005) had two objectives: (a) establish the difference in *levels of comfort* of graduate students in a statistics and research course that was team-taught versus solo-taught, and (b) determine the difference in *student achievement* in a statistics and research course that was team-taught versus solo-taught. In that study, Carpenter et al. found that the team-taught (TBL intervention) section (n=55) recorded a lower effect size (d= 0.43) compared to the solo-taught (control) section (n=47), which had an effect size that was slightly higher (0.54). These effect sizes would not be relevant to the current POP study because the student investigator used a different survey tool to capture the study endpoints.

Therefore, she did not extrapolate their effect size to the survey instruments used in the Carpenter et al. (2005) study. Furthermore, the sample sizes used in the Carpenter et al. study did not influence the sample size of the current study because this study design was different and with different outcomes measured. However, the sample sizes used in the current POP study were much larger than those used by Carpenter et al. Therefore, the current study would probably have a greater power. However, without a power analysis of the results Carpenter et al. obtained, it cannot be confirmed. In the current POP study, all analyses confirmed a power greater than 80% (see Table 5.7).

Review of the Conceptual Framework

Before conducting the research, the student investigator offered the conceptual model of the relationship between SA, SSE, and the type of learner. She suggested that the aspects of SSE are influenced by the type of learner because adult learners report higher levels of SA. Therefore, she expected to demonstrate lower levels of SSE. According to the conceptual framework, SSE aspects and the type of learner together contribute to the level of SA. The combination of these factors jointly plays a role in attrition rates in nursing schools and possibly result in the nursing shortage.

The DID analysis results indicate that the conceptual framework was partially confirmed. However, some adjustments are needed. The type of learner variable may influence SSE in other ways than the student investigator initially explained. Adult learners did show a higher level of anxiety and a lower level of self-efficacy, which was consistent with Bui and Alfaro's (2011) previous research and the student investigator's expectations. However, it is possible that additional factors other than age influence self-efficacy in learning statistics and related SA. In addition to these data, younger students and female students may adjust better to the statistics curriculum with the help of TBL (as shown in the interviews). Individualized reactions to TBL suggest that the type of lecture may also play a significant role in how undergraduate nursing statistics students estimate their statistical competencies and how they feel about statistics. Therefore, each of these aspects has a further impact on the SA level.

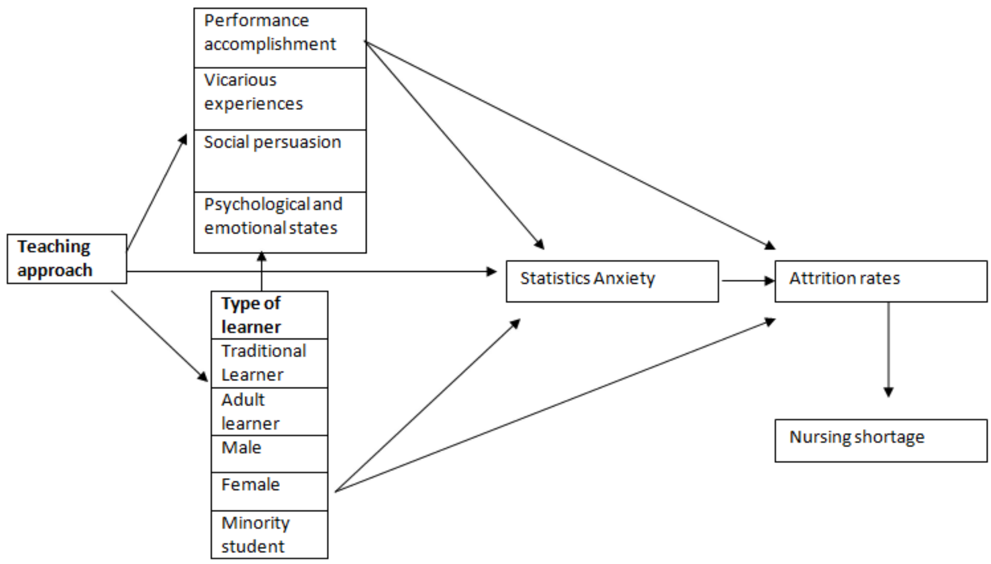
The student investigator created an updated conceptual model after she analyzed and interpreted this study's results (see Figure 5.2). Compared to the original conceptual framework (see Figure1-1), the revised model emphasizes the teaching approach, how it can influence SA and SSE, and how it can affect attrition rates in undergraduate nursing programs. The teaching approach, whether it is TBL or traditional teaching, can lead directly to changes in

SA. For instance, undergraduate nursing students may find some teaching or evaluation methods anxiety-inducing.

Furthermore, it is possible that the SA level in students is a consequence of their SSE level, which the teaching approach may affect. However, not every learner type will have an identical response to the same teaching approach. Some learners with diverse backgrounds, including different genders, races, and ages, may respond positively to TBL, while others may prefer traditional learning. The updated conceptual framework highlights the reciprocal relationships between the factors that may influence the nursing shortage. Moreover, each of these elements has a unique contribution to attrition rates in undergraduate nursing education. Their influences cannot be fully understood if the elements are examined independently from one another.

Figure 5.2

Updated Conceptual Model



Alignment with Theory

The student investigator predicted the results of the study with the ToT (see Table 4.1). The critical assumption she made was that if a TBL intervention were utilized, nursing students would have lower levels of SA, which the student investigator expected would lead to higher levels of SSE and improved achievement in statistics and other mathematics-related courses. The assumptions of this causal chain included that (a) changing SA changes SSE, (b) decreasing anxiety improves achievement, (c) university instructors are willing to incorporate TBL into their curriculum, and that (d) TBL is an effective learning strategy in statistics. The results partially confirmed the theory since there was a connection between SA and SSE. There is evidence that TBL can be a useful strategy that could lead to SA reduction, although further research is needed to determine the impact of interfering factors on SA and SSE. A follow-up study that would measure the long-term outcomes (retention in the nursing program by reducing attrition caused by statistics-related anxiety) would be necessary to get a broader picture of the intervention effects.

The student investigator illustrated intervention components with an LM (see Figure 4.2) that focused on the outcomes, inputs, and activities that were not included in the ToT model, which described the components thoroughly. Furthermore, the student investigator fulfilled the planned work and completed the intervention and research as she had intended. In general, the outcomes of the intervention were positive, with the participants identifying many advantages and benefits of TBL. However, the anticipated results were only partially confirmed related to decreasing SA since the TBL intervention did not have a significant effect on the students' self-efficacy. Therefore, the student investigator suggests further research that would implement different types of team-based activities directed specifically at self-efficacy.

In general, the curriculum helped the students think of new ways to apply the course content after the class. One of the most significant advantages that students mentioned was that working with a group can bring multiple points of view to a project, resulting in less room for errors. Some participants reported increased confidence as a result of the TBL initiatives. All of this indicates that TBL can be a beneficial addition to the traditional curriculum if applied carefully and if the students' individual preferences are considered.

These findings suggest that it is essential for an instructor to consider students' opinions when they create a curriculum. The strength of this study lies in its diverse methodology, which identified multiple benefits, as well as some possible limitations of a TBL intervention in the statistics classroom. The combining of quantitative and qualitative data provided an opportunity to do an in-depth analysis of the intervention outcomes. Furthermore, the quasi-experimental design was the most appropriate to conduct this research as it met the practical requirements of school administration and ethics. The qualitative findings strengthened the findings of the quantitative study and even provided new, compelling data.

This research can serve not only as a framework for further research on the topic's design but can also provide evidence for educational practice in teaching statistics. The results highlight the importance of a learner-centered approach in teaching, which would let the students discuss the curriculum and contribute actively to the program of their studies.

Working as a Team in Nursing

Apart from the hard, clinical skills required in the nursing profession, future nurses also must prepare and train to develop soft skills to collaborate with doctors, other nurses, and employees, as well as patients. Therefore, interdisciplinary collaboration and teamwork have become a mandatory requirement for nurses who work in any clinical setting (Atwal & Caldwell, 2006; Cioffi & Ferguson, 2009). Nurses must adjust to teamwork requirements and learn how to collaborate with people who may have different opinions, training, and areas of expertise. However, these changes in practice may lead to some difficulties. In a qualitative observational study, Atwal and Caldwell (2006) identified some of the factors that could hinder teamwork efficiency in nurses, such as different perspectives on the roles of team participants. Moreover, they highlighted the importance of giving all members of a team an opportunity to take part in decision-making processes equally so that they take into account the opinions of the team—not just the team leaders. In their profession, nurses can be team leaders and members of a team at the lower level of the hierarchy. As a result, TBL could provide future nurses with a good starting point to prepare for each of these roles.

Furthermore, the preparation for team-based clinical practice may be essential to make the most of the benefits that team-based care can bring to the patients. When Cioffi and Ferguson (2009) interviewed 15 nurses to investigate their opinions on team nursing in acute care settings, the participants identified many benefits of team-based nursing and described it as being "patient-oriented, facilitating accountability, encouraging collaboration, enabling better coverage of patients and providing better access to experienced nurses as a reference point for their decision-making" (p. 5). However, the nurses also complained about not having enough preparation for these activities. It is significant that the groundwork for team-based actvities is during nurses' undergraduate education. Moreover, as Johanson (2008) argued, the best way for nurses to practice teamwork with other experts is to collaborate with each other.

Significance of Statistics in Nursing Research

Nurses are usually involved in clinical trials as a part of research teams because they participate in various stages of medical research. As a part of a research team, nurses must not only assist in diverse team-based activities, but must have statistical literacy. Statistical literacy is vital to clinical trial team collaboration and to provide patients with evidence-based information that nurses obtain when they review the relevant research. Implementing research in clinical practice has become a necessity due to the requirements of evidence-based practice as it brings many benefits to the patient (Chummun & Tiran, 2008; Hommelstad & Ruland, 2004). Nurses must interpret the findings to understand the results of research on patients' medical conditions. However, as researchers have shown, implementing the results of research in their practice may be a challenge for nurses (Chummun & Tiran, 2008; Hommelstad & Ruland, 2004; Spilsbury et al., 2008). Some of these factors include lack of time and lack of support from doctors (Hommelstad & Ruland, 2004) and lack of confidence (Spilsbury et al., 2008). In their study, Kuuppelomäki and Tuomi (2005) sampled 400 nurses in Finland, where the majority of the participants said that research remained distant from their practice.

Educational intervention may raise awareness and knowledge of using research in the nursing practice (Hundley et al., 2000). Therefore, it would be beneficial for future nurses to obtain the education necessary for evidence-based practice while preparing for their profession in undergraduate nursing programs. By becoming accustomed to reading scientific papers, academic writing, and conducting their research while in college, nurses may become comfortable reading, understanding, and applying statistical principles. In turn, these skills could enable them to follow the requirements of evidence-based practice while meeting the patients' needs, providing them with the information obtained from relevant, peer-reviewed research.

Divergent Thinking

Divergent thinking is a thought process used to generate diverse and numerous ideas on an intellectual task, implying that not just one solution is correct (Razumnikova, 2012). One of the aspects of TBL intervention in this study was the generation of different ideas between participants. The students in the current study identified the ability to hear different opinions and ideas from their teammates as one of the most significant advantages of TBL. The findings indicate that TBL offered the students a chance to find new solutions to problems outside of what the instructors taught them. The students had an opportunity to take multiple points of view into consideration when making a decision. These aspects of the intervention included an increase of divergent thinking among team members since there were many different ways and opinions on how to approach the mutual task. These findings were similar to Zhang et al.'s (2015) research, where a generation of diverse ideas linked to intrinsic motivation.

Similarly, discussions with teammates in the current study gave the students a chance to think about concepts in a creative way, motivating them to apply the course material differently. Knowledge-sharing in team-based discussions is a multidirectional process in which learners analyze their knowledge within the discourse and build upon the knowledge of other people's contributions simultaneously (Weinberger et al., 2007). Divergent perspectives can be vital in this process. Furthermore, Puntambekar (2006) explained the development of collaborative knowledge building that occurs in TBL through moving from divergent perspectives and resulting in the construction of new, creative ideas. Therefore, divergent thinking is a significant aspect of social learning situations that take into account each other's perspective, leading to a shared understanding of the material.

In their article, Laal and Ghodsi (2012) identified numerous academic, social, and psychological benefits of TBL and the diverse opinions vital to developing students' critical thinking. As the student investigator concluded from the current study's results, TBL can bring many benefits to educational practice on divergent thinking and its related intrinsic motivation and creativity. Divergent thinking and its benefits during TBL are understood through the concept of group ZPD that Nyikos and Hashimoto (1997) offered. According to these authors, individuals engaged in collaborative learning possess in their subjective ZPD different opinions and ideas within group interactions and dynamic interrelationships. Moreover, when group ZPD occurs, it offers the participants a chance to progress through social mediation. Even though their concept was not entirely relevant in their study of the cognitive development of the students, their results emphasized the importance of affective components of individual and group progress in TBL, which could contribute to the results obtained in the current study.

Limitations

Given the limitations of this study, the student investigator was cautious when interpreting the findings. Although the quasi-experimental design provides many practical and ethical advantages, the design did not interfere with the placement of students in classes. Students self-selected into either the control or intervention groups, depending on the academic year in which they enrolled in the course. The research design would have been more compelling had the students been randomly assigned to either the control or intervention groups. Therefore, since the students self-selected the control and intervention groups, it may have caused the student investigator some difficulties in interpreting the data and drawing any conclusions on causality.

Furthermore, it was difficult to establish whether students' decreasing SA influenced scores on statistics exams or whether it was the improving test scores that impacted students' levels of SA. It would be helpful to assess indicators of achievement, such as test scores, project scores, course grades, and academic grade point averages. Another potential limitation to consider is that the student investigator conducted the intervention at a large, private, faith-based institution in Southern California, and only students pursuing a nursing major were included in the study. This may have affected the external validity since the results obtained in this study may not be generalizable to all undergraduate nursing students studying statistics.

Additionally, both universities required IRB approval ([name of university redacted for publication] and the Johns Hopkins University). The IRB was a time-intensive process and required repeated revisions of the letter of consent since both universities had their standard template. Furthermore, [name of university redacted for publication] is not a research university. Therefore, the IRB process was not streamlined and took longer than anticipated. This process resulted in such a long delay that it precluded the ability of the student investigator to conduct the needs assessment at the study site, and instead, collect the data from a different population at a different university.

A disproportionate number of females and White participants were sampled due to the demographic profile of students in the nursing major. Therefore, the student investigator recommends including an intentional focus on inclusivity in future studies. Diverse sampling by race and gender would strengthen the analysis by considering the effects of demographic confounders.

Similarly, there was a limitation due to the use of two different samples. The quantitative results included African American students; however, there were no students self-identified as African American in the qualitative results. It is possible that there were some African American participants included under the N/A category, or there may have been none. Ideally, the participants in the qualitative analyses were a subset of the participants in the quantitative analyses, but that was not always the case. In some places, students participated in the pre-test, post-test, or interview, but not all three and not always two of the three. This discrepancy produced a limitation when trying to match students across the quantitative and qualitative sections.

The student investigator conducted this POP study in an online course. She recommends future research to assess these relationships in a face-to-face undergraduate nursing statistics course. Due to differing pedagogies, TBL practices may be implemented differently in face-to-face versus online courses. One of the strengths of using an online course, however, is that it was easy for the student investigator to observe the course and the group interactions. In a face-to-face class, she would have needed strategic methods to observe and evaluate the course.

In summary, the study represents an excellent initial step toward embracing a mixed-method approach in the research of SA, SSE, and TBL. Future work should concentrate on enhancing the quality of sample characteristics to make the findings generalizable. Including students from different colleges and applying the true experimental design would also strengthen the research methodology. Furthermore, qualitative data are essential to determine why some students do not find TBL convenient, as well as improved teaching techniques. In the study of educational practices, flexibility is desirable. Accordingly, conducting action research on the topic would be beneficial.

As for the practical value of this study, it offers various recommendations to statistics educators. Of primary importance is the understanding that using TBL as an addition to a traditional teaching approach can be valuable. As some students in this study claimed, TBL helped them see problems from multiple points of view and to discuss possible solutions with their group members. Therefore, TBL facilitated collaboration amongst the students, allowing them to contribute their strengths to the group and create a bank of shared knowledge. As SA is negatively related to SSE and performance, this finding can encourage statistics educators to think of alternative ways to evaluate student knowledge, and one of the ways can be TBL initiatives, such as group projects.

Following the students' recommendations for improvements may prove crucial to make TBL an effective evaluation strategy. This course of action entails respect for students' individual differences and preferences by letting them choose the learning approach that best fits their needs. For instance, the participants in this research suggested not to make random group assignments and, instead, have them comprise two members, not three. They indicated that this structure would ensure accountability amongst group members. Students also suggested group assignments be in line with the homework assignments. This observation implies that the obligations related to the course material should relate in a way that is inherently apparent to students.

Implications

Teaching

The results of this POP study provided the instructor with insights into the value of diversifying pedagogies and assessment methods on student anxiety levels in undergraduate nursing statistics courses. The instructor taught the class in the manner in which she had been taught statistics, which was with lectures and exams. When the student investigator first proposed this project, some people stated that it was impossible to do TBL in an online class. Therefore, it was challenging to convince people that this intervention was possible. Hopefully, these results will encourage instructors of other nursing classes to review these results and consider TBL an appropriate method for their classes, too.

In the current study, the instructor reported that her self-efficacy also increased as a result of this intervention. She felt confident that using the project in place of the final exam gave her additional ways to intervene, clarify, and reteach complicated concepts.

Attrition

By finding ways to develop the curriculum and pedagogy that best supports student learning outcomes, additional licensed nurses should complete their degrees, reducing the nursing shortage facing California and the rest of the country. Moreover, these techniques apply when developing a curriculum for any course that has a high attrition rate and where students report high levels of anxiety and low levels of self-efficacy.

Recommendations

External and Internal Validity

The student investigator recommends conducting this type of study with students from diverse universities to focus on increasing the representation of genders, races, and ethnicities. Accordingly, it may improve upon the generalizability of the results the student investigator obtained. In this sample, the number of men and non-White genders was so low that when adjusted for age, race, and gender, the statistically significant results became null. A lack of inclusivity could account for those results. The student investigator also recommends that this type of intervention have a full experimental design where all students interested in taking statistics are randomly assigned to either the control or intervention groups, thus improving internal validity. Moreover, this study focused on undergraduate nursing students; however, similar effects could be observed in graduate nursing students and other health science statistics students.

Additional Survey Instruments

Other variables that researchers could use when designing similar studies include divergent thinking, creativity, and prior mathematics learning experiences. Part of the reason that this final project was successful in decreasing anxiety is that it focused on divergent thinking, where there were many different ways to approach answering the problems. The multiple-choice exams utilized in the control group course focused on convergent thinking, which may have impacted students' SA levels. The results indicated that students were most anxious about tests and quizzes in that group. Additionally, the team-based project the instructor utilized in the intervention group course allowed students creativity with their research questions, explanations, and presentations. These differences between convergent and divergent learning may have also impacted SA and SSE levels outside of the TBL capacity.

Another concept discussed in the qualitative responses was the effect that the passage of time had on learners who had last taken a math class years ago. This effect was especially apparent in older students who had been out of school for a long time. While the quantitative portion did ask about previous mathematics experiences, it did not explicitly ask about the number of years since the student's last mathematics class. That could have been essential information to assess when considering the reasons adult learners experience different levels of anxiety than traditional students.

Conclusion

Further research is needed to identify valuable teaching strategies that could lower students' SA and enhance their SSE. It is also necessary to examine the effects of teaching approaches that embrace the principles of TBL other than a group project that embraces the principles of TBL. Therefore, to help future nurses develop statistical literacy, acknowledging their concerns is essential to demonstrating the value of the material. The results of this POP study highlight the importance of providing students with a chance to apply the curriculum while feeling comfortable at the same time. As Knowles et al. (2005) argued, adults learn better when they can incorporate their experiences into the learning process and when the material includes real-life problems. The evidence from this study points toward the use of individualized, diverse, and novel teaching techniques that could encourage students to actively participate in classes while decreasing the academic pressure placed on them.

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Appendix A

Statistics Anxiety Measure

Please **answer the following demographic questions.**

1. What is your gender?

a. Female
b. Male

2. What is your race/ethnicity?

a. African American
b. Asian/Pacific Islander
c. Latin American
d. Middle Eastern
e. Native American
f. White

3. What is your age?

4. What is your major?

5. What is your minor?

6. What type of degree are you currently seeking?

a. Traditional BSN
b. RN to BSN
c. LVN
d. 2+2
e. ELM
f. MSN
g. DNP
h. PhD
i. Please rate the following activities in terms of how anxious they make you feel.

7. Taking tests in this class.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

8. Explaining your statistical findings.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

9. Formulating and testing hypotheses.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

10. Interpreting statistics.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

11. Taking statistics.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

12. Calculating probabilities.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

13. Developing conclusions based on mathematical solutions.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

14. Reading statistical studies.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

i. Please rate the following statements in terms of how much you agree or disagree with them.

15. I am worried about taking statistics.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

16. Based on past experiences, I expect the material covered in this class and the exams to be difficult.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

17. I worry about doing well in this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

18. I’ve struggled to follow the material covered in statistics classes in the past.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

II. Please rate the following statements in terms of how much you agree or disagree with them.

1. If there was a way I could avoid taking this class, I would.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

2. I do not expect to enjoy this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

3. I expect this class to be boring.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

4. I am only taking this class because it is required.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

5. I will never use what I learn in this class again.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

6. My ability to calculate statistics will not affect my chances of getting a job in my chosen field.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

7. I lack the motivation to learn or continue learning statistics.

a. Strongly Disagree
b. Disagree
c. Agree

d. Strongly Agree

8. Taking this class will have little impact on my life.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

9. There is no room to be creative in statistics.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

III. Please rate the following statements in terms of how much you agree or disagree with them.

19. I was hesitant to register for this class.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

20. I am afraid to ask for help in this class.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

21. I have been worried ever since I was informed of this class as a requirement for my degree.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

22. I avoided taking this class for as long as possible.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

IV. Please rate the following statements in terms of how much you agree or disagree with them.

1. My math reasoning ability is low.

a. Strongly Disagree

b. Disagree

c. Agree

d. Strongly Agree

2. Math is my least favorite subject.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

3. I dislike math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

4. I've never enjoyed working with numbers.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

5. I am not good at math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

6. I have never enjoyed classes that involve math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

7. I dislike working with numbers.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

8. I have low self-esteem when it comes to math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

9. Math is the subject where I have the least amount of confidence.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

10. My least enjoyable experiences in school involved math.

V. Please rate how you expect to perform in the following areas.

1. Developing an appropriate methodology to test a given hypothesis.

a. Above Average
b. Average
c. Below Average
d. Fail

2. Solving equations using the calculator/computer.

a. Above Average
b. Average
c. Below Average
d. Fail

3. Projects.

a. Above Average
b. Average
c. Below Average
d. Fail

4. Making accurate conclusions based on statistical findings.

a. Above Average
b. Average
c. Below Average
d. Fail

5. Exams.

a. Above Average
b. Average
c. Below Average
d. Fail

6. Explaining my answers.

a. Above Average
b. Average
c. Below Average
d. Fail

7. Quizzes.

a. Above Average
b. Average
c. Below Average
d. Fail

8. Interpreting my answers.

a. Above Average
b. Average
c. Below Average
d. Fail

Appendix B

Alignment Between Research Questions and Statistics Anxiety Measure Survey Questions

Research question	Questions from survey part 2	Questions from survey part 3	Questions from survey part 5	Questions from survey part 6
1. How does anxiety impact graduate student performance in statistics classes?	a. Taking tests in this class b. Explaining your statistical findings c. Formulating and testing hypotheses d. Interpreting statistics e. Taking statistics f. Calculating probabilities g. Developing conclusions based on mathematical solutions			A. Developing appropriate methodology to test a given hypothesis B. Projects C. Making accurate conclusions D. Exams E. Explaining my answers F. Quizzes G. Interpreting my answers

Appendix B (cont.)

Research question	Questions from survey part 2	Questions from survey part 3	Questions from survey part 5	Questions from survey part 6
2. In what ways does statistics anxiety relate to general mathematics anxiety?	A. Based on past experiences, I expect the material to be hard		A. My math reasoning ability is low	A. Solving equations using the calculator/computer
	B. I've struggled to follow the material covered in the past		B. Math is my least favorite subject	
			C. I dislike math	
			D. I have never enjoyed working with numbers	
			E. I am not good with math	
			F. I have never enjoyed classes that involve math	
			G. I dislike working with numbers	

Appendix B (cont.)

Research question	Questions from survey part 2	Questions from survey part 3	Questions from survey part 5	Questions from survey part 6
			H. I have low self-esteem when it comes to math I. Math is the subject where i have the least amount of confidence J. My least enjoyable experiences in school involved math	
3. What value do students see in taking statistics?		A. if there was a way I could avoid taking this class I would B. I do not expect to enjoy this class C. I expect this class to be boring		

Appendix B (cont.)

Research question	Questions from survey part 2	Questions from survey part 3	Questions from survey part 5	Questions from survey part 6
		D. I am only taking this class because it’s required E. I will never use what I learn in this class again F. My ability to calculate statistics will not affect my chances of getting a job G. I lack the motivation to learn or continue learning statistics. H. Taking this class will have little impact on my life		

Appendix C

Evaluation Criteria

Control Evaluation Criteria

Activity	Points
Assignments	10 each = 70 points
Quizzes	5 each = 60 points
Faith integration forum	5 each = 20 points
Final exam	75 points
Module exams	15 each = 75 points
Total	300 points

Intervention Evaluation Criteria

Activity	Points
Assignments	10 each = 70 points
Group modules	5 each = 60 points
Faith integration forum	5 each = 20 points
Team-based learning project	75 points
Module exams	15 each = 75 points
Total	300 points

Appendix D

Rubric for Team-Based Learning Project

Activity	Points
Make a hypothesis about something related to statistics where two or more different groups can be compared.	2 points
Conduct a literature review of related concepts and ideas.	4 points
Write the operational and conceptual definitions of your independent and dependent variables.	4 points
Turn in a copy of your survey, identifying the question type for each question.	5 points
Obtain data by surveying friends or family, students, or coworkers, with a minimum of 30 people in each group.	5 points
Put the data into frequency tables by category.	4 points
Graph the data as a histogram.	4 points
Find n, mean, median, and mode for the data.	4 points
Calculate the standard deviation and variance for each category of data.	4 points
Complete the appropriate statistical test for the research question. Properly show the hypothesis, raw data, and summary table.	10 points
Write a two paragraph summary of the findings.	10 points
Write a one paragraph reflection on the strengths and limitations of the study, and the implications for future research.	10 points
Present the data, findings, and results in a visual presentation to the class.	10 points

Appendix E

Self-Efficacy

Self-Efficacy to Learn Statistics (SELS) Pre-Test

Please rate your confidence in learning the skills necessary while you are in this class to complete the following tasks successfully. The item scale has 6 possible responses: (1) = *no confidence at all*, (2) = *a little confidence*, (3) = *a fair amount of confidence*, (4) = *much confidence*, (5) = *very much confidence*, (6) = *complete confidence*. For each task, please mark the one response that represents your confidence in learning the skills necessary in this course to complete the task successfully.

1. Identify the scale of measurement for a variable.
2. Interpret the probability value (p-value) from a statistical procedure.
3. Identify if a distribution is skewed when given the values of three measures of central tendency.
4. Select the correct statistical procedure to use to answer a research question.
5. Interpret the results of a statistical procedure in terms of the research question.
6. Identify the factors that influence power.
7. Explain what the value of the standard deviation means regarding the variable being measured.
8. Distinguish between a Type I error and a Type II error in hypothesis testing.
9. Explain what the numeric value of the standard deviation is measuring.
10. Distinguish between the objectives of descriptive versus inferential statistical procedures.
11. Distinguish between the information given by the three measures of central tendency.
12. Distinguish between a population parameter and a sample statistic.
13. Identify when you use the mean, median, and mode as a measure of central tendency.
14. Explain the difference between a sampling distribution and a population distribution.

Appendix E (cont.)

Current Statistics Self-Efficacy (Post-Test)

Please rate your confidence in your current ability to successfully complete the following tasks. The item scale has 6 possible responses: (1) = *no confidence at all*, (2) = *a little confidence*, (3) = *a fair amount of confidence*, (4) = *much confidence*, (5) = *very much confidence*, (6) = *complete confidence*. For each task, please mark the one response that represents your confidence in learning the skills necessary in this course to complete the task successfully.

1. Identify the scale of measurement for a variable.
2. Interpret the probability value (p-value) from a statistical procedure.
3. Identify if a distribution is skewed when given the values of three measures of central tendency.
4. Select the correct statistical procedure to use to answer a research question.
5. Interpret the results of a statistical procedure concerning the research question.
6. Identify the factors that influence power.
7. Explain what the value of the standard deviation means regarding the variable being measured.
8. Distinguish between a Type I error and a Type II error in hypothesis testing.
9. Explain what the numeric value of the standard deviation is measuring.
10. Distinguish between the objectives of descriptive versus inferential statistical procedures.
11. Distinguish between the information given by the three measures of central tendency.
12. Distinguish between a population parameter and a sample statistic.
13. Identify when you should use the mean, median, and mode as a measure of central tendency.
14. Explain the difference between a sampling distribution and a population distribution.

Appendix F

Initial Recruitment Email

Hello, my name is Marissa Brash. I am a faculty member at [name of university redacted for publication] as well as a graduate student at the Johns Hopkins University in the School of Education. For my doctoral dissertation, I am conducting research on how statistics curriculum affects statistics anxiety in undergraduate nursing students, and I am inviting you to participate because you are an undergraduate nursing student currently enrolled in a statistics course.

Participation in this research includes taking a survey about your attitudes toward statistics experiences, which will take approximately 30 minutes. You will take a survey in the first and last modules of the course. If you agree to participate in a follow-up interview about your view of the specific experiences in the statistics course of which you are currently enrolled, that will take approximately 30 minutes.

Your instructor will not view your responses, and your participation in this study will in no way impact your performance in the statistics course.

If you have any questions, I can be reached at [email address redacted for publication]. Thank you for helping us to collect this valuable data!

Appendix G

Survey Recruitment Email with Informed Consent

Hello, my name is Marissa Brash. I am a faculty member in the School of Nursing at [name of university redacted for publication] as well as a graduate student at the Johns Hopkins University in the School of Education. I am conducting research on how statistics curriculum affects statistics anxiety in undergraduate nursing students, and I am inviting you to participate because you are an undergraduate nursing student currently enrolled in a statistics course.

Participation in this research includes taking a survey about your attitudes toward statistics experiences, which will take approximately 30 minutes. You will take a survey in the first and last modules of the course.

Your instructor will not view your responses, and your participation in this study will in no way impact your performance in the statistics course.

If you have any questions, I can be reached at mbrash@apu.edu. Thank you for helping us to collect this valuable data!

Informed Consent:

Voluntary Status: You are being invited to participate in a survey research study. Your participation is voluntary, which means you can choose whether or not you want to participate. You may withdraw any time without penalty.

Purpose: The study for which you are being asked to participate is designed to assess the effectiveness of the statistics curriculum in decreasing the statistics anxiety in undergraduate nursing students enrolled in an online statistics course.

Possible Risks: It is expected that participation in this study will provide you with no more than minimal risk or discomfort, which means that you should not experience it as any more troubling than your normal daily life. While the student investigator provides no direct benefits for participating, your response will help us to understand the research topic better.

Confidentiality: The investigator involved with the study will not be collecting any personal information for the study. All responses to this survey are anonymous and confidential. Your name or identity will not be linked in any way to the research data. Concerning your rights or treatment as a research subject, you may contact the Research Integrity Officer at [university name and phone number redacted for publication].

Appendix G (cont.)

Consent: I understand that my participation in this study is entirely voluntary and that I may refuse to participate or may withdraw from the study at any time without penalty. I have read this entire form, and I understand it completely. By clicking below and completing the online assessments that follow, I am giving my consent to participate in this study.
LINK to STUDY

Appendix H

Interview Recruitment E-mail

Hello, my name is Marissa Brash. I am a faculty member at [name of university redacted for publication] as well as a graduate student at the Johns Hopkins University in the School of Education. I am contacting you because you recently enrolled in an undergraduate nursing statistics course at [name of university redacted for publication] and completed the Statistics Students Survey. As part of my doctoral dissertation, I am conducting one-on-one interviews to understand further how the statistics curriculum affects specific statistics experiences. We are currently seeking volunteers from the undergraduate nursing statistics courses as participants in this study.

Participation in this study involves signing up for a time slot on the attached Google Docs document and then meeting for about 45 minutes over Google Hangouts. The questions will focus on how confident you felt completing specific activities and assessments in the statistics course. I would like to assure you that the study has been reviewed and received ethics clearance through the IRB at [name of university redacted for publication] and the Johns Hopkins University.

If you are interested in participating, please complete the attached informed consent document. Once I have received this, you will receive access to a Google Docs document where you can sign up for one of the available interview times. I will then send a confirmation email indicating that you have been signed up for that time and provide you with further information concerning the study. If you have to cancel your appointment, please email me at [email address redacted for publication].

Sincerely,
Marissa Brash

Appendix I

Interview Script

Thank you for agreeing to speak with me today.

The purpose of this interview is to get your feedback about how the statistics curriculum affects your experiences in the course. Specifically, we want to understand what experiences helped you to complete the statistics course successfully. We also want to understand what barriers you encountered, and what you knew and did to overcome those barriers.

I want to hear from you what assessments and experiences made you feel the most and the least confident in your statistics ability. I would also like to know what motivated you to enroll in the course and what activities helped you to complete it.

I would like to remind you that to protect your privacy, transcripts will be coded with pseudonyms, and I would like to ask that you not discuss what is discussed in this interview with anyone else.

The interview will last about 45 minutes and will be audiotaped to make sure that your responses are recorded accurately.

Do you have any questions for me before we begin?

Appendix J

Interview Questions

1. What made you enroll in this course?
2. What do you attribute to staying enrolled in this course?
3. Please tell me about your perceptions of team-based learning within the context of the nursing statistics course.
    a. Follow up question 1. Can you think of any examples of specific advantages or disadvantages of working on in-class projects as part of a problem-solving team in the nursing statistics course?
        i. What about that was advantageous/why do you think that was disadvantageous?
    b. Follow up question 2. If you had a choice between working on statistics problems individually or as part of a team, which would you choose? And why?
4. Can you tell me a little bit about how confident you felt during this course? Which activities did you like the most, and during which activities did you feel most confident? Were there any activities or assessments where you felt less sure of yourself? How about the quizzes? How did you feel during those? I would like you to comment on how certain activities contribute to your confidence in the statistics course.
    a. Follow up question 1. Can you tell me about how you felt when taking exams in the statistics course?
    b. Follow up question 2. Please tell me how you felt when taking quizzes or working on projects in the statistics course.
    c. Follow up question 3. Please tell me how you felt about the final assessment in the statistics course.
5. Were there any activities or assessments that specifically impacted your feelings about this course?
    a. And why do you think those activities affected you positively or negatively?
    b. What about those experiences did you like (or didn't like)?

Appendix J (cont.)

6. What might you change about the activities if you had a chance to do it over again?
   a. What would you recommend to an instructor who might be teaching this course, especially for students who might feel the same way about the activities as you felt?
7. How do you think you might use the content from this course in your personal or professional contexts?

Appendix K

Self–Other Team Assessment

Select the Module Number

- Module 1
- Module 2
- Module 3
- Module 4

Select Your Name

- Student X
- Student Y
- Student Z

Using the scale provided, evaluate your contributions to the group project as well as the contributions of each of your teammates

Student	Did not contribute at all	Low-level contribution	OK, but could have contributed more	An active and helpful contribution	Vital and valuable level of contribution
Student X					
Student Y					
Student Z					

Use this space to describe your participation or share comments with the instructor briefly.

Appendix L

Statistics Students Survey

Pre-Test

Please answer the following demographic questions.
1. What is your gender?
a. Female b. Male
2. What is your race/ethnicity?
a. African American b. Asian/Pacific Islander c. Latin American d. Middle Eastern e. Native American f. White
3. What is your age?
4. What is your major?
5. What is your minor?
6. What type of degree are you currently seeking?
a. Traditional BSN b. RN to BSN c. LVN d. 2+2 e. ELM f. MSN g. DNP h. PhD i. Please rate the following activities in terms of how anxious they make you feel.
7. Taking tests in this class.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious
8. Explaining your statistical findings.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious
9. Formulating and testing hypotheses.
a. Not Anxious

b. Slightly Anxious
c. Anxious
d. Very Anxious

10. Interpreting statistics.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious
11. Taking statistics.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious
12. Calculating probabilities.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious
13. Developing conclusions based on mathematical solutions.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious
14. Reading statistical studies.
a. Not Anxious b. Slightly Anxious c. Anxious d. Very Anxious i. Please rate the following statements in terms of how much you agree or disagree with them.
15. I am worried about taking statistics.
a. Strongly Disagree b. Disagree c. Agree d. Strongly Agree
16. Based on past experiences, I expect the material covered in this class and the exams to be difficult.
a. Strongly Disagree b. Disagree c. Agree d. Strongly Agree

17. I worry about doing well in this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

18. I've struggled to follow the material covered in statistics classes in the past.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

II. Please rate the following statements in terms of how much you agree or disagree with them.

1. If there was a way I could avoid taking this class, I would.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

2. I do not expect to enjoy this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

3. I expect this class to be boring.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

4. I am only taking this class because it is required.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

5. I will never use what I learn in this class again.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

6. My ability to calculate statistics will not affect my chances of getting a job in my chosen field.

a. Strongly Disagree

b. Disagree
c. Agree
d. Strongly Agree

7. I lack the motivation to learn or continue learning statistics.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

8. Taking this class will have little impact on my life.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

9. There is no room to be creative in statistics.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

III. Please rate the following statements in terms of how much you agree or disagree with them.

19. I was hesitant to register for this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

20. I am afraid to ask for help in this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

21. I have been worried ever since I was informed of this class as a requirement for my degree.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

22. I avoided taking this class for as long as possible.

a. Strongly Disagree
b. Disagree
c. Agree

d. Strongly Agree

IV. Please rate the following statements in terms of how much you agree or disagree with them.

1. My math reasoning ability is low.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

2. Math is my least favorite subject.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

3. I dislike math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

4. I've never enjoyed working with numbers.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

5. I am not good at math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

6. I have never enjoyed classes that involve math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

7. I dislike working with numbers.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

8. I have low self-esteem when it comes to math.

a. Strongly Disagree

b. Disagree
c. Agree
d. Strongly Agree

9. Math is the subject where I have the least amount of confidence.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

10. My least enjoyable experiences in school involved math.

V. Please rate how you expect to perform in the following areas.

1. Developing an appropriate methodology to test a given hypothesis.

a. Above Average
b. Average
c. Below Average
d. Fail

2. Solving equations using the calculator/computer.

a. Above Average
b. Average
c. Below Average
d. Fail

3. Projects.

a. Above Average
b. Average
c. Below Average
d. Fail

4. Making accurate conclusions based on statistical findings.

a. Above Average
b. Average
c. Below Average
d. Fail

5. Exams.

a. Above Average
b. Average
c. Below Average
d. Fail

6. Explaining my answers.

a. Above Average
b. Average
c. Below Average
d. Fail

7. Quizzes.
a. Above Average
b. Average
c. Below Average
d. Fail
8. Interpreting my answers.
a. Above Average
b. Average
c. Below Average
d. Fail

Please rate your confidence in learning the skills necessary while you're in this class to successfully complete the following tasks. The item scale has 6 possible responses: (1) = *no confidence at all*, (2) = *a little confidence*, (3) = *a fair amount of confidence*, (4) = *much confidence*, (5) = *very much confidence*, (6) = *complete confidence*. For each task, please mark the one response that represents your confidence in learning the skills necessary in this course to complete the task successfully.

1. Identify the scale of measurement for a variable.
2. Interpret the probability value (p-value) from a statistical procedure.
3. Identify if a distribution is skewed when given the values of three measures of central tendency.
4. Select the correct statistical procedure to be used to answer a research question.
5. Interpret the results of a statistical procedure in terms of the research question.
6. Identify the factors that influence power.
7. Explain what the value of the standard deviation means in terms of the variable being measured.
8. Distinguish between a Type I error and a Type II error in hypothesis testing.
9. Explain what the numeric value of the standard deviation is measuring.
10. Distinguish between the objectives of descriptive versus inferential statistical procedures.
11. Distinguish between the information given by the three measures of central tendency.
12. Distinguish between a population parameter and a sample statistic.

13. Identify when the mean, median, and mode should be used as a measure of central tendency.
14. Explain the difference between a sampling distribution and a population distribution.

Post-Test

I. Please answer the following demographic questions.

1. What is your gender?

a. Female
b. Male

2. What is your race/ethnicity?

a. African American
b. Asian/Pacific Islander
c. Latin American
d. Middle Eastern
e. Native American
f. White

3. What is your age?

4. What is your major?

5. What is your minor?

6. What type of degree are you currently seeking?

a. Traditional BSN
b. RN to BSN
c. LVN
d. 2+2
e. ELM
f. MSN
g. DNP
h. PhD

II. Please rate the following activities in terms of how anxious they make you feel.

7. Taking tests in this class.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

8. Explaining your statistical findings.

a. Not Anxious
b. Slightly Anxious
c. Anxious

d. Very Anxious

9. Formulating and testing hypotheses.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

10. Interpreting statistics.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

11. Taking statistics.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

12. Calculating probabilities.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

13. Developing conclusions based on mathematical solutions.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

14. Reading statistical studies.

a. Not Anxious
b. Slightly Anxious
c. Anxious
d. Very Anxious

i. Please rate the following statements in terms of how much you agree or disagree with them.

15. I am worried about taking statistics.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

16. Based on past experiences, I expect the material covered in this class and the exams to be difficult.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

17. I worry about doing well in this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

18. I've struggled to follow the material covered in statistics classes in the past.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

II. Please rate the following statements in terms of how much you agree or disagree with them.

1. If there was a way I could avoid taking this class, I would.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

2. I do not expect to enjoy this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

3. I expect this class to be boring.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

4. I am only taking this class because it is required.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

5. I will never use what I learn in this class again.

a. Strongly Disagree
b. Disagree
c. Agree

d. Strongly Agree

6. My ability to calculate statistics will not affect my chances of getting a job in my chosen field.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

7. I lack the motivation to learn or continue learning statistics.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

8. Taking this class will have little impact on my life.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

9. There is no room to be creative in statistics.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

III. Please rate the following statements in terms of how much you agree or disagree with them.

19. I was hesitant to register for this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

20. I am afraid to ask for help in this class.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

21. I have been worried ever since I was informed of this class as a requirement for my degree.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

22. I avoided taking this class for as long as possible.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

IV. Please rate the following statements in terms of how much you agree or disagree with them.

1. My math reasoning ability is low.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

2. Math is my least favorite subject.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

3. I dislike math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

4. I've never enjoyed working with numbers.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

5. I am not good at math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

6. I have never enjoyed classes that involve math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

7. I dislike working with numbers.

a. Strongly Disagree
b. Disagree
c. Agree

d. Strongly Agree

8. I have low self-esteem when it comes to math.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

9. Math is the subject where I have the least amount of confidence.

a. Strongly Disagree
b. Disagree
c. Agree
d. Strongly Agree

10. My least enjoyable experiences in school involved math.

V. Please rate how you expect to perform in the following areas.

1. Developing an appropriate methodology to test a given hypothesis.

a. Above Average
b. Average
c. Below Average
d. Fail

2. Solving equations using the calculator/computer.

a. Above Average
b. Average
c. Below Average
d. Fail

3. Projects.

a. Above Average
b. Average
c. Below Average
d. Fail

4. Making accurate conclusions based on statistical findings.

a. Above Average
b. Average
c. Below Average
d. Fail

5. Exams.

a. Above Average
b. Average
c. Below Average
d. Fail

6. Explaining my answers.

a. Above Average

b. Average
c. Below Average
d. Fail

7. Quizzes.

a. Above Average
b. Average
c. Below Average
d. Fail

8. Interpreting my answers.

a. Above Average
b. Average
c. Below Average
d. Fail

Please rate your confidence in your current ability to successfully complete the following tasks. The item scale has 6 possible responses: (1) = *no confidence at all*, (2) = *a little confidence*, (3) = *a fair amount of confidence*, (4) = *much confidence*, (5) = *very much confidence*, (6) = *complete confidence*. For each task, please mark the one response that represents your confidence in learning the skills necessary in this course to complete the task successfully.

1. Identify the scale of measurement for a variable.
2. Interpret the probability value (p-value) from a statistical procedure.
3. Identify if a distribution is skewed when given the values of three measures of central tendency.
4. Select the correct statistical procedure to be used to answer a research question.
5. Interpret the results of a statistical procedure in terms of the research question.
6. Identify the factors that influence power.
7. Explain what the value of the standard deviation means in terms of the variable being measured.
8. Distinguish between a Type I error and a Type II error in hypothesis testing.
9. Explain what the numeric value of the standard deviation is measuring.
10. Distinguish between the objectives of descriptive versus inferential statistical procedures.
11. Distinguish between the information given by the three measures of central tendency.
12. Distinguish between a population parameter and a sample statistic.

13. Identify when the mean, median, and mode should be used as a measure of central tendency.
14. Explain the difference between a sampling distribution and a population distribution.

Appendix M

Implementation of Fidelity Adherence Table

Objective	Program features	Adherence (Yes/no)
As a result of team-based learning (TBL) intervention, students will reduce the level of statistical anxiety and improve the level of statistical self-efficacy	Formation of strategic permanent heterogeneous teams	Yes
	Readiness assurance process	No
	Team engagement in prescribed activities	Yes
	Peer evaluation process	Yes
	Group and individual accountability	Yes
	Structured discussions	Yes
	Motivational aspects	Yes
	Feedback cycles including re-teaching	Yes
	Total score (0-100%)	87.5%

Curriculum Vitae: Marissa Brash

MARISSA BRASH, DRPH, EDD (C), MPH, CPH

Core competencies

- Research & Development
- Accreditation & Assessment
- Alternative Learning
- Performance Evaluation
- Administration
- Strategic Planning
- Performance Optimization
- Time Management
- Leadership, Coaching, & Mentorship
- Curriculum Design
- Community Partnerships
- Interprofessional Education & Collaboration
- Laboratory Compliance

Professional Experience

Department Chair – [name of university redacted for publication] 2018–Present

Assistant Professor – [name of university redacted for publication] 2016–Present

Social Chair– American Public Health Association, Public Health Education and Health Promotion Subcommittee 2020

Medical Science Advisory Board Member– Global Genes 2016–Present

Assistant Professor & Division Chair –Southern California University of Health Sciences 2014–2016

Assistant Professor & Program Director– Southern California University of Health Science 2013–2016

Adjunct Faculty–Vanguard University, Psychology Department 2011–2016

Instructor–The Princeton Review 2008–2016

Faculty–University of Phoenix 2010–2014

Adjunct Faculty–National University 2013–2015

Education

Doctor of Education (EdD)– Major: Mind, Brain, **Teaching,** Johns Hopkin University, 2015–2019

Doctor of Public Health (DrPH)– Major: Epidemiology, Loma Linda University, 2013

Master of Public Health (MPH)– Major: Biostatistics, Loma Linda University, 2008

Bachelor of Science (BS)– Biochemistry, University of San Francisco, 2004

Awards

Above and Beyond Award– Southern California University–2015

Grit Award– Southern California University–2014

Instructor of the Year– The Princeton Review, West Coast–2013

Faculty Member of the Year– University of Phoenix, Southern California Campus–2012

Publications

1: **Brash, M.** (2013). *The effect of lifestyle on Systemic Lupus Erythematosus (SLE)* (Doctoral dissertation, Loma Linda University).

2: Dodd-Butera, T., Beaman, M., & **Brash, M.** (2019). Environmental health equity: A concept analysis. *Annual Review of Nursing Research* (submitted).

3: Kizhakkeveettil, A., Vosko, A. M., **Brash, M.**, & Philips, M. A. (2017). Perceived stress and fatigue among students in a doctor of chiropractic training program. *Journal of Chiropractic Education*, *31*(1), 8–13. https://doi.org/10.7899/JCE-15-27

Presentations

1 : World Congress on Public Health and Nutrition; March 10, 2015; Madrid, Spain; **Presentation**: Epigenetics and Systemic Lupus Erythematosus
2 : Integrated Health Symposium; November 7, 2015; Whittier, CA; **Presentation**: Public Health Interventions for Chronic Diseases
3 : Common Day of Learning; March 1, 2017; Azusa, CA; **Presentation**: Best Practices in Nursing Based on Research
4 : Education Research Conference; July 31, 2017; Baltimore, Md; **Poster Presentation**: From Chaos to Clarity: The Evolution of a Concept Map
5: WASC Senior College and University Commission Academic Resource Conference; April 20, 2017; San Diego, CA; **Presentation**: Collaborative Culture for Campus Change
6: International Mind, Brain, Education Society; September 29, 2018; Los Angeles, CA; **Poster Presentation**: Addressing Statistics Anxiety in Undergraduate Nursing Students
7: American Public Health Association; November 12, 2018; San Diego, CA; **Presentation**: Interdisciplinary Perspectives on Researching, Educating, and Identifying the Concepts
8: Big Data Discovery Summit; March 16, 2019; Azusa, CA; **Presentation**: Pilot Testing for a Rare-Disease Self-Identification Tool
9: NACAS CX; July 20, 2019; Chicago, Ill. **Workshop**: Do it Once and Do it Right: Aligning Auxiliaries and Academics